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TM 9692

Video Sweep Unit

INSTRUCTION MANUAL

MP MASTER
MA30913

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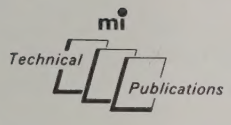
MARCONI INSTRUMENTS

Instruction Manual
No. EB 9692
for

Video Sweep Unit

TM 9692



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ST. ALBANS HERTFORDSHIRE ENGLAND

G.L. 0.75c
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EB 9692
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Chapter 1

General information

1.1 INTRODUCTION

The TM 9692 Video Sweep Unit operates in conjunction with the TF 2361 Sweep Generator, and the two units together form a general-purpose instrument suitable for many applications in testing video frequency responses.

The video sweep unit fits into a recess at the top of the sweep generator, from which it receives power supplies and control signals via a 24-way connector. Full details of the sweep generator are contained in the sweep generator instruction manual.

The video sweep unit produces an output signal variable from 25 kHz to 30 MHz, the variation being controlled by a sweep voltage from the main unit. The sweep can be centred at any point in the frequency range, and the sweep width varied from zero to the maximum available on either side of the centre frequency.

A marker generator produces a marker at every 1 MHz interval, those at 5 MHz intervals being distinguished from the others by different height and shape.

Additional features include a linear or semi-log sweep facility, variable a.l.c., wide or narrow sweep, and 61 dB output attenuation available in 1 dB steps.

The instrument can be set to any of the operational modes selected by a front panel function switch on the main unit. This gives a range of internal sweep drive from 0.01 Hz to 100 Hz in four decades, mains lock to mains frequencies from 45 to 400 Hz, TV lock to frame scan on 405, 525 or 625 composite television signals, external control by signals from d.c. to 20 kHz, a c.w. mode in which the instrument behaves as an ordinary signal generator, and a manual mode in which a manual rate control is used to manually sweep over the range of frequencies set up on the plug-in oscillator. The ratio of sweep to flyback can be set at 10:1 or 1:1 and on the internal ranges the instrument can be set to give a single sweep when a switch is operated.

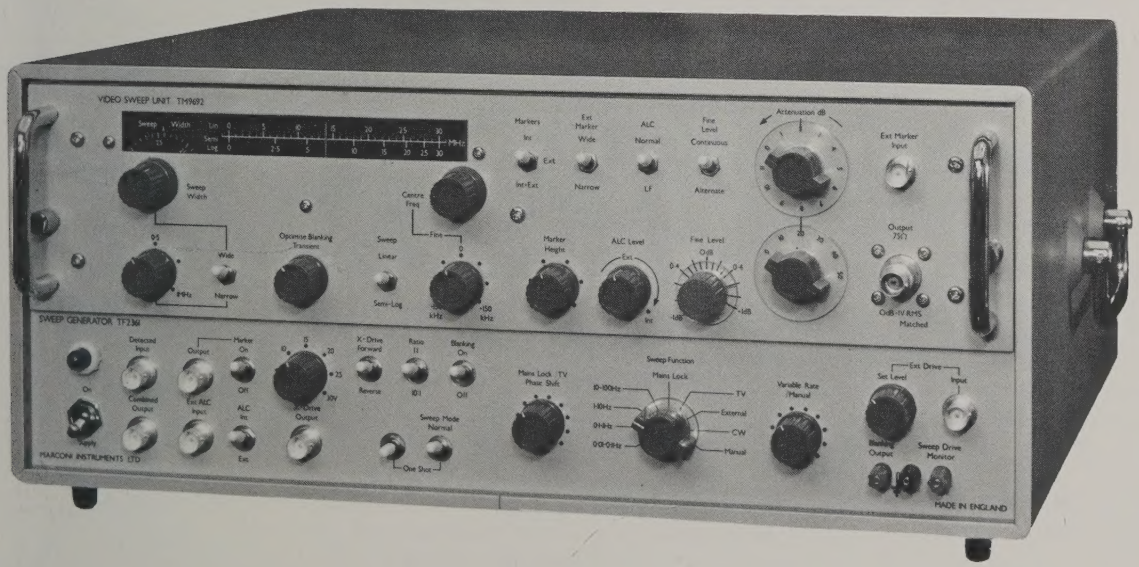


Fig. 1.1 Video Sweep Unit TM 9692, fitted in Sweep Generator TF 2361

1.2 DATA SUMMARY

Characteristics	*Performance*	*Supplementary information*
General characteristics		
Frequency range:	25 kHz to 30 MHz in one band.	
Output level:	1 V r.m.s. ±2.5% at 0 dB at 75 Ω.	
Fine level:		Provides variable shift of up to ±1 dB, or variable separation of alternate traces up to ±1 dB.
Fine level maximum error:	±0.05 dB at ±1 dB points.	
Output impedance:	75 Ω ±3% unbalanced.	
R F output flatness:		±0.1 dB at 0 dB from 25 kHz to 30 MHz.
Overall detected system flatness (with TM 9703 detector):	±0.05 dB at 0 dB from 25 kHz to 30 MHz.	
Stability:	Drift less than 30 kHz/15 minutes after 45 minutes warm-up period.	Typically 15 kHz/15 minutes. After 3 hours the random drift is typically ±25 kHz. Temperature coefficient 5 kHz/°C.
Residual frequency modulation:	Less than 300 Hz peak at 1.5 MHz, less than 800 Hz peak at 30 MHz.	
Total harmonic distortion:	Better than 40 dB down, 25 kHz to 30 MHz.	Typically 50 dB.
Spurious signals:	Better than 45 dB down, 25 kHz to 30 MHz.	Typically 60 dB.
Sweep width		
Range:	Continuously variable from 0 to 30 MHz.	
Dial accuracy (linear scale):	±3% of sweep width ±1.0 MHz.	
Narrow range (linear scale):	Continuously variable from 0 to 1 MHz nominal.	
Sweep linearity (linear scale):	±2% of full sweep width. Maximum ratio of any two 1 MHz intervals less than 1.4:1.	

Characteristics	Performance	Supplementary information
Centre frequency		
Accuracy:	Linear: The frequency accuracy at any 1 MHz scale marking is within ±0.5 MHz. Semi-log: The frequency accuracy at zero scale reading is within ±0.5 MHz. The frequency accuracy at 30 MHz scale reading is within ±3 MHz.	
Fine control (linear scale):	Nominal frequency shift ±150 kHz.	
Attenuators		
Range:	61 dB (5 x 10 dB and 11 x 1 dB).	
Accuracy:	±0.25% of attenuator reading ±0.05 dB.	
Flatness:	At any attenuated level the output flatness is maintained within ±0.1 dB ±0.2% of attenuator reading, from 25 kHz to 30 MHz.	
Automatic level control		
Time constant:		Normal: for use above 500 kHz. LF: for use below 500 kHz.
Level adjustment:	Provides a means of resetting the internal level when using external a.l.c.	
Optimize blanking transient control:		Will eliminate the usual overshoot at the start of the sweep.
Internal markers		
Form:		Birdie-derived 5 MHz comb markers, pulse markers at intermediate 1 MHz points. May be displayed separately or with external markers.
Amplitude:	Variable up to 3.5 V ±0.5 V (1 MHz markers) and 5.3 V ±0.5 V (5 MHz markers).	
Accuracy:	5 MHz markers crystal-controlled, 1 MHz markers ±15 kHz.	

Characteristics	Performance	Supplementary information

External markers

Form:	Derived from external c.w. signal. May be displayed separately or with internal markers.
Amplitude:	Greater than 2 V p-p for 125 mV r.m.s. input.
Bandwidth:	Selector switch gives wide or narrow bandwidth marker output.

Power supplies +24 V, -24 V and +110 V d.c. supplies obtained from main unit TF 2361.

Dimensions and weight

Height	*Width*	*Depth*	*Weight*
95 mm (3.75 in)	420 mm (16.5 in)	305 mm (12 in)	9.0 kg (20 lb)

1.3 ACCESSORIES

Accessories supplied

	Description	*M.I. code*
①	Video Detector TM 9703 Detects the video waveform for display on an oscilloscope or chart recorder. Full-wave positive-going output. Frequency response from 30 MHz to 25 kHz. Includes : 75 Ω Termination	46838-005 23443-396
	Kit, comprising :	46883-061
	Free Plug type BNC (2 off)	23443-374 23443-371
②	Adapter type BNC male to male	23443-558
	Accessory Case TM 9935	41675-014

Optional accessories

③	Video ALC Detector TM 9704 To ensure a flat response when a long length of cable connects the sweep generator to the equipment under test. Full-wave negative-going output. Switched output impedance 75 Ω or zero.	46838-006

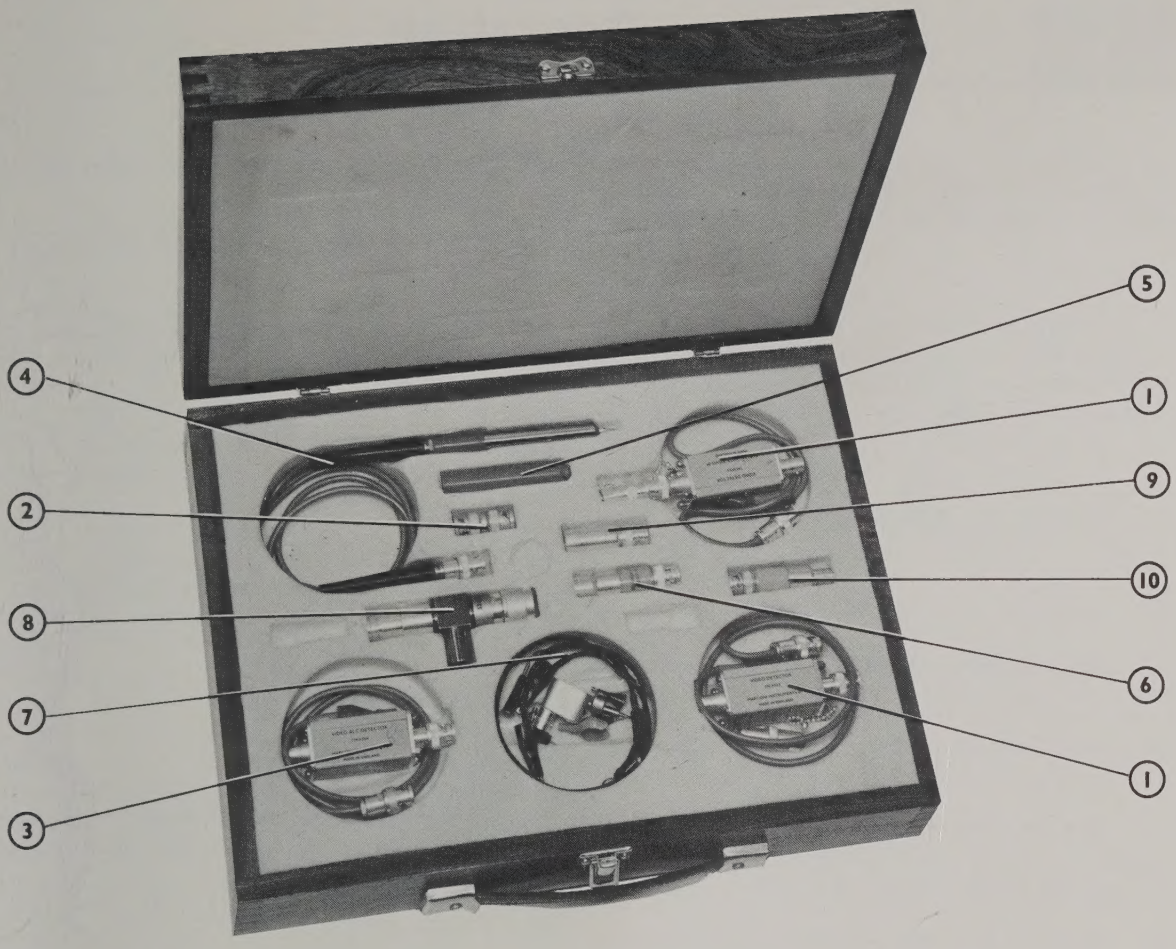


Fig. 1.2 A selection of accessories

	Description	*M.I. code*
④	Video Probe Detector TM 9651 An alternative to TM 9703 when a high impedance detector is required. Input impedance : 120 kΩ shunted by 3.3 pF. Full-wave positive-going output. Includes :	44416-078
⑤	Insulating Sleeve	37486-519
⑥	LF Adapter, to extend the time constant for use below 100 kHz	23448-591
⑦	Accessory Kit TM 9737	46883-029
⑨	BNC Adapter, for connecting TM 9651 to a BNC socket	23443-801
⑧	T-Connector TM 7948 For connecting TM 9651 to a type N plug and a type N socket.	43167-007
	100 :1 Multiplier TM 7947 For attaching to the end of TM 9651.	44416-050
⑩	Pad 75Ω to 50Ω	54411-021

Chapter 2

Operation

All the information in this chapter treats the instrument as a single unit comprising the Video Sweep Unit TM 9692 and Sweep Generator TF 2361.

Details of installation, rack mounting arrangements, supply voltage adjustment, mains lead and fuses are contained in the instruction manual for the Sweep Generator TF 2361.

2.1 CONTROLS—MAIN UNIT

① SUPPLY: A.C. mains on/off switch.

② SUPPLY INDICATOR LAMP: Lamp will glow when supply is switched ON.

③ SWEEP FUNCTION: Sets the sweep generator to any one of nine operational modes.

④ PHASE SHIFT: Varies the phase of the sweep output over a range of at least 270° with respect to the input trigger in mains lock or TV mode.

⑤ VARIABLE RATE: Gives continuous variation over selected range on internal sweep modes, and sufficient control in mains lock and TV modes to cover mains frequencies from 45 to 400 Hz and TV systems of 405, 525 or 625 lines. When ③ is set to MANUAL, this control can be used to give manual sweep.

⑥ RATIO: Selects a ratio of sweep to flyback of either 1:1 or 10:1. Affects video output, blanking output and X-drive output.

⑦ SWEEP MODE: In ONE SHOT position, brings one shot switch ㉓ into operation.

⑧ BLANKING: With the blanking on, the video output is turned off during the sweep flyback. This provides a convenient base line for the display.

⑨ A.L.C. SWITCH: Switches a.l.c. from internal control to control from external a.l.c. detector via socket ⑲

⑩ MARKER SWITCH: Switches marker output from sweep unit to combined output socket ㉑ and marker output socket ⑪

⑪ MARKER OUTPUT: Markers direct from sweep unit, via switch ⑩

⑫ X-DRIVE OUTPUT: Provides horizontal sweep for associated oscilloscope or chart recorder, synchronized with sweep rate.

⑬ X-DRIVE LEVEL CONTROL: Sets X-drive output level from 0 to 30 V p-p into 50 kΩ load, or from 0 to 2 V p-p into 1 kΩ load.

⑭ EXT DRIVE INPUT: An input signal from d.c. to 20 kHz will sweep the generator when the SWEEP FUNCTION switch is set to EXTERNAL.

⑮ EXT DRIVE SET LEVEL: Adjusts sensitivity of EXT DRIVE INPUT.

⑯ BLANKING OUTPUT: Square wave output of blanking generator (1:1 or 10:1 according to position of RATIO switch) of +22 V for synchronizing or triggering associated equipment. Synchronized with sweep rate.

⑰ EARTH SOCKET:

⑱ SWEEP DRIVE MONITOR: Monitors the sweep output from distorter and drive unit in video sweep unit.

⑲ EXT A.L.C. INPUT: Automatic level control from external a.l.c. detector via a.l.c. switch ⑨.

⑳ DETECTED INPUT: Accepts input from the detector in use so that markers may be added.

㉑ COMBINED OUTPUT: Combination of detected input and markers (with MARKER switch ON).

㉒ X-DRIVE SWITCH: To suit the polarity requirements of an associated oscilloscope or chart recorder connected to the X-drive output, the output horizontal sweep waveform may be either positive-going when the switch is set to FORWARD or negative-going when set to REVERSE.

㉓ ONE SHOT: Spring-loaded switch, operational with SWEEP MODE switch in ONE SHOT position, triggers sweep for one cycle when released.

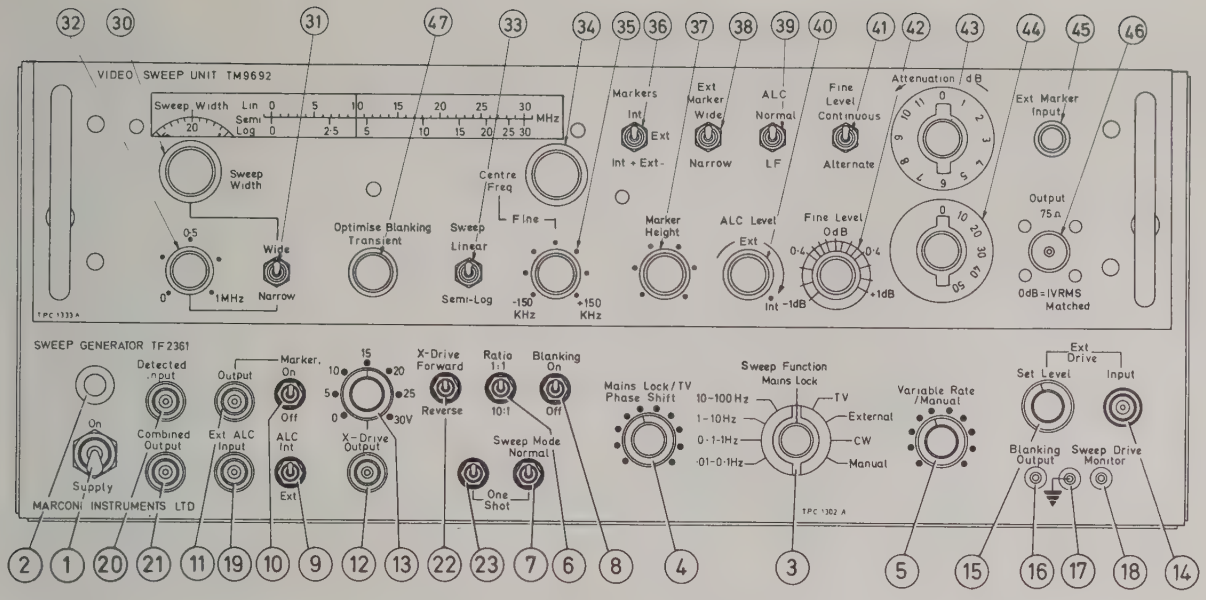


Fig. 2.1 Controls and connections

2.2 CONTROLS —SWEEP UNIT

(30) SWEEP WIDTH (wide): Operates when the SWEEP WIDTH SELECTOR (31) is in the WIDE position to control the width of sweep about the centre frequency. A mechanical interlock prevents frequency excursions beyond the instrument's range. The calibration of the sweep width dial applies only when 33 is set to LINEAR.

(31) SWEEP WIDTH SELECTOR: Brings controls (30) (wide) or (32) (narrow) into operation.

(32) SWEEP WIDTH (narrow): Operates when the SWEEP WIDTH SELECTOR (31) is in the NARROW position; gives sweep width control from 0 to 1 MHz about centre frequency as set by centre frequency controls.

(33) SWEEP LINEARITY: Selects either linear or semi-log sweep waveform.

(34) CENTRE FREQUENCY: Varies centre point of sweep from 0 to 30 MHz, as indicated on scale visible through rectangular window.

(35) FINE CENTRE FREQUENCY: Gives ±150 kHz variation about selected centre frequency.

(36) MARKERS: Switch giving choice of marker source: internal, external, or internal plus external.

(37) MARKER HEIGHT: Controls height of internal and external markers.

(38) EXTERNAL MARKER BANDWIDTH: Gives narrow marker for use at low sweep widths.

(39) A. L. C. BANDWIDTH: Switch giving extended a. l. c. time constant in l. f. position, to improve response between 1 MHz and 25 kHz.

(40) A. L. C. LEVEL : When in the counter-clockwise unswitched range, controls the output signal. When fully clockwise switched to the CAL position, the output signal is 1 V r.m.s. when the FINE LEVEL control is at 0 dB.

(41) FINE LEVEL SELECTOR: In the ALTERNATE position, the FINE LEVEL control is effective on alternate sweeps only, giving a double trace display on an oscilloscope.

(42) FINE LEVEL : Gives a ±1 dB variation of the output signal from a reference level set by means of the ALC LEVEL control. According to the setting of the FINE LEVEL SELECTOR, the variation is applied continuously or to alternate sweeps.

(43) FINE ATTENUATOR: 1 dB steps of output attenuation up to 11 dB.

(44) COARSE ATTENUATOR: 10 dB steps of output attenuation up to 50 dB.

(45) EXTERNAL MARKER INPUT: Socket taking direct input to external marker circuit. Input level 500 mV.

(46) VIDEO OUTPUT: Output of sweep generator via the coarse and fine attenuators. Output is 1 V r.m.s. at 0 dB attenuation, matched into 75 Ω.

(47) OPTIMIZE BLANKING TRANSIENT: The control is used to optimize the effect of the transient that occurs after a flyback with blanking on.

To achieve the wide operational flexibility of this instrument a large number of toggle switches are provided. The normal manner of use corresponds, for each, to the up position. Until you become familiar with the function of each, or if difficulty is encountered in obtaining the expected behaviour, you are recommended to start with all toggle switches UP.

2.3 RESPONSE DISPLAY

Introduction

Many types of narrow band circuits require accurate checking and careful setting up in order to meet the required performance, and this can be a difficult and lengthy process. The sweep generator has facilities for rapid and accurate checking of such circuits as i.f. amplifiers and band-pass filters.

The CENTRE FREQUENCY and SWEEP WIDTH controls can be adjusted until the response of the circuit is seen over each sweep cycle. Adjustments carried out to alter one part of the characteristic may also affect another part, and such effects can be immediately seen so that optimum adjustments can be made.

The gain of an i.f. amplifier may be measured by first displaying the unattenuated sweep directly on the oscilloscope, and then displaying it through the i.f. amplifier with sufficient attenuation to make the two displays have an identical level. The attenuation inserted is a measure of the amplifier gain.

The 3 dB points on a curve can be fixed by adding 3 dB attenuation to the displayed characteristic and noting the horizontal graticule line that passes through the peak of the curve. Remove the 3 dB attenuation, and the same graticule line will cut the curve at the 3 dB points.

Connections

To display the response characteristic of a circuit or a complete equipment within the frequency range of the video sweep unit, a detector and a display unit, which can be either an oscilloscope or an X-Y recorder, are required.

(1) Connect the video output from the sweep generator to the equipment under test and the output from this equipment to the detector.

(2) The detected output can be connected direct to the display unit but if, as is usual, markers are to be displayed, connect the detector to the DETECTED INPUT of the sweep generator and the COMBINED OUTPUT to the display unit - vertical input of an oscilloscope, Y input of an X-Y recorder.

(3) Connect the X-DRIVE of the sweep generator to the display unit - horizontal input of an oscilloscope, X input of an X-Y recorder.

Take care that video frequency connections are made with the correct impedance cable and connectors, and that proper terminating impedances are provided where necessary, since otherwise the mismatch produced can cause misleading response characteristics. The video output impedance is 75 Ω, but where it is desired to work into a 50 Ω system a matching pad is available as an optional accessory.

Detectors

A Video Detector TM 9703 is supplied with the instrument; this is suitable for connection between units of a matched system (bridging measurements), or as the final item in a system when it must be fitted with an appropriate terminating impedance. For most measurements use the NORMAL position of the detector time

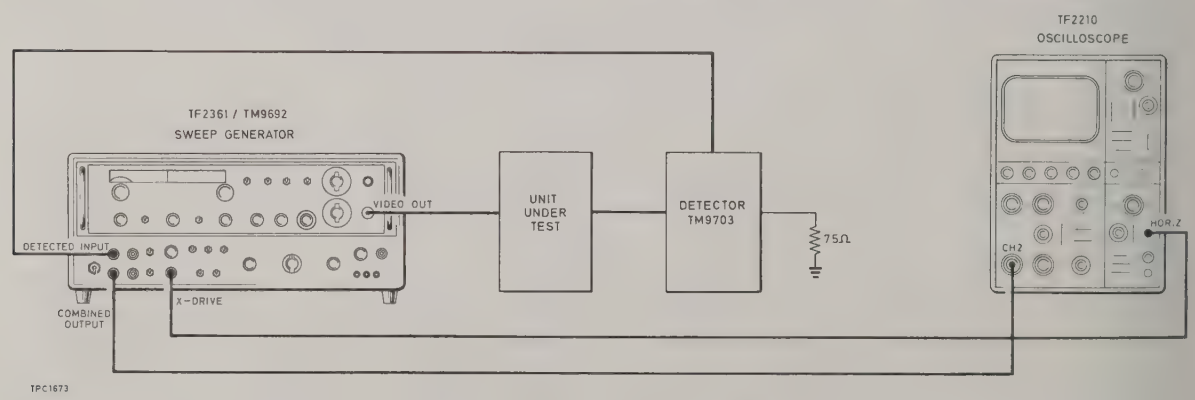


Fig. 2.2 Connections for response display

constant switch, but if frequencies below about 250 kHz are important use the L. F, position, to give a longer time constant to the detector circuit.

Video Probe Detector TM 9651, which is available as an optional accessory, is a high impedance probe suitable for connection to a circuit at any point, rather than one of a particular impedance. It is particularly convenient to use within a circuit because of the range of tips provided. For measurements below about 100 kHz, use the l.f. adapter to extend the detector circuit time constant.

Internal sweep

(1) Turn the SWEEP FUNCTION switch to one of the positions 0.01 - 0.1 Hz, 0.1 - 1 Hz, 1 - 10 Hz or 10 - 100 Hz according to the range in which the sweep rate is wanted to lie and make fine adjustments to the rate with the VARIABLE RATE control.

In general, select as slow a sweep rate as will allow the display to be viewed comfortably. High sweep rates must particularly be avoided if:

(a) low frequencies are being swept,
(b) the detector has a long time constant, e.g. TM 9703 switched to L. F. ,
(c) the circuit under test has a steep slope to its characteristic, e.g. a filter or a high Q tuned circuit.

To check whether the sweep rate is too fast, turn the RATIO switch to 1:1 and the BLANKING switch to OFF. The display should then consist of identical forward and return traces exactly superimposed; if the two traces are separated the sweep rate must be reduced. The effect is shown in Figs. 2.3 and 2.4.

If an X-Y recorder is being used, a rate within the lowest range (0.01 - 0.1 Hz) will be needed, since the pen cannot slew over the chart in less than about 0.5 s.

(2) Set the SWEEP LINEARITY switch to LINEAR; normally the SEMI-LOG position is only used when close examination of the l.f. portion of the sweep is wanted.

(3) Adjust the CENTRE FREQUENCY control so that the scale indicates the frequency that is to lie at the centre of the swept band.

(4) If the swept band is to be less than 1 MHz wide, set the SWEEP WIDTH SELECTOR to NARROW and set the NARROW SWEEP WIDTH control (lower control) to the desired sweep. For wider sweeps, set the SWEEP WIDTH SELECTOR to WIDE and use the WIDE SWEEP WIDTH control to adjust the sweep width. The width is shown on the dial in the window immediately above the control.

NOTE: There is a mechanical interlock between the WIDE SWEEP WIDTH and CENTRE FREQUENCY controls to prevent the instrument being set up for a frequency excursion beyond its range.

(5) Select the ratio of sweep to flyback desired using the RATIO switch. Normally 10:1 is used, but 1:1 can be selected to give a slower flyback, useful where the detector time constant is not short compared with the flyback rate.

(6) Set the SWEEP MODE switch to NORMAL.

(7) Adjust the X-DRIVE LEVEL control and X-DRIVE switch to suit the sensitivity and polarity of the display oscilloscope or recorder.

2.4 OUTPUT

Internal A.L.C.

Set the A.L.C. switch to INTERNAL. Set the A.L.C. BANDWIDTH selector to NORMAL for most applications or to L.F. if frequencies below about 1 MHz are to be examined. Set the A.L.C.

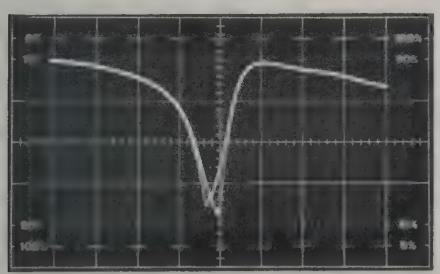


Fig.2.3 Swept display of a filter — rate too high

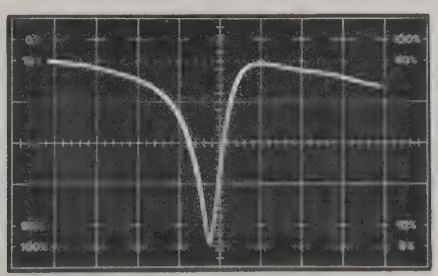


Fig.2.4 Swept display of a filter — correct rate

LEVEL control fully clockwise switched to the INT position.

A coarse and a fine step attenuator affect the output level; the total range of control is 61 dB in 1 dB steps. In addition the FINE LEVEL control provides up to ±1 dB further variation of the level. The level, in dB referred to 1 V, at the VIDEO OUTPUT socket is thus given by the algebraic sum of the settings of the two stepped attenuators and the FINE LEVEL control. To find the output level in volts, use the decibel conversion tables at the end of this chapter.

To work with a 50 Ω system, a matching pad must be used, such as the 75 Ω - 50 Ω pad GE80032 available as an optional accessory; this pad has a voltage loss equivalent to reducing the sweep generator output by 10 dB.

External A.L.C.

Where the equipment under test is located some distance from the sweep generator, with a resulting loss of flatness due to the length of leads, external a.l.c. can be used with advantage to improve the flatness.

(1) Connect the Video A. L. C. Detector TM 9704 between the unit under test and the lead from the VIDEO OUTPUT socket.

(2) Connect the detected output from the a.l.c. detector to the sweep generator EXTERNAL A. L. C. input.

(3) Make other connections and set the controls to display the response as described in Sect. 2.3.

(4) Set the A. L. C. switch to INTERNAL and note the position on the display of the lowest point of the response curve. Turn the A. L. C. switch to EXTERNAL and adjust the A. L. C. LEVEL control so that the lowest point on the response curve is at the position it occupied with the switch at INTERNAL.

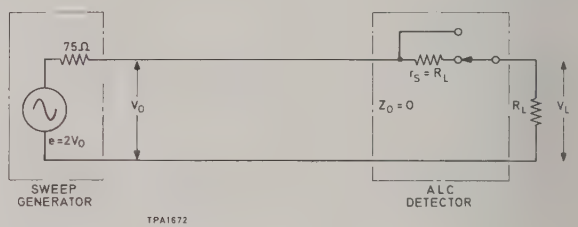


Fig. 2.6 Equivalent circuit with external a.l.c.

Owing to the a.l.c. action, the source impedance is effectively zero at the diode connection point and, to make the impedance finite for matching to the load, a series resistor must be connected. TM 9704 has provision for switching in a 75 Ω resistor, or if some other value is required it may be provided externally. The equivalent circuit is shown in Fig. 2.6.

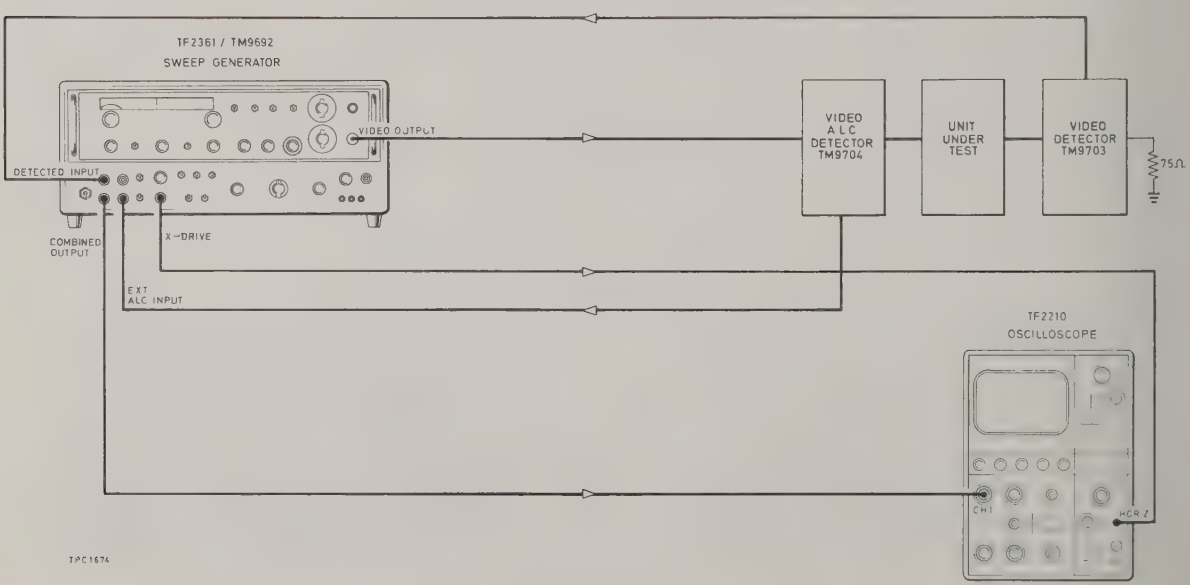


Fig. 2.5 Connections for external a.l.c.

When a series resistor is used the voltage developed in the load will be smaller than the sweep generator indicated output voltage. The voltage developed across the load R_L is

$$V_L = 2V_o \frac{R_L}{75 + 2R_L} = \frac{V_o}{1 + \frac{75}{2R_L}}$$

where V_o is the voltage which would be developed by the sweep generator direct into a 75 Ω load.

For 75 Ω systems $V_L = \frac{2}{3} V_o$

Since with external a.l.c. the attenuators are within the control loop they cannot be used to directly control the output level. To obtain full control of the output level without loss of performance a separate attenuator should be used between the a.l.c. detector and the unit under test. However, the internal attenuators can be used to give control of the level if the A.L.C. LEVEL control is reset, as described in step 4 above, each time the amount of attenuation is altered. The use of the attenuators in this way reduces the loop gain of the control system, but up to about 20 dB can be used before the fall-off in performance becomes noticeable.

Blanking transient

The sudden change at the high frequency end of the sweep, caused when the sweep restarts after a flyback with blanking on, causes the a.l.c. to overcompensate because of its relatively long time constant, which is necessary to cover operation at lower frequencies. To overcome this effect, adjust the OPTIMIZE BLANKING TRANSIENT control so that the blanking transient appears as a slight positive pulse at the beginning of the sweep. The setting depends upon the output level and must be checked whenever the level is changed. Note particularly that misadjustment of the OPTIMIZE BLANKING TRANSIENT control can produce a very misleading response curve.

Alternate sweep

The effect of the fine level control can be applied every sweep or it can be confined to alternate sweeps. Which mode of operation applies is governed by the setting of the FINE LEVEL SELECTOR switch. With the FINE LEVEL SELECTOR at ALTERNATE every other sweep is changed in amplitude by an amount set up by the FINE LEVEL control; the swept response will be displayed as two traces separated by this amount.

This facility is particularly suited to measurement of flatness.

(1) Set the sweep generator to display the response as described in Sect. 2.3, with the FINE LEVEL control at 0 dB and the FINE LEVEL SELECTOR at CONTINUOUS.

(2) Adjust the position of the display so that, say, the lowest portion of the trace is positioned on a convenient graticule line.

(3) Switch the FINE LEVEL SELECTOR to ALTERNATE and adjust the FINE LEVEL control so that the highest portion of the separated trace is positioned on the same graticule line.

(4) The indication of the FINE LEVEL control is then the total deviation from flat of the response.

Fig. 2.7 shows the technique in use.

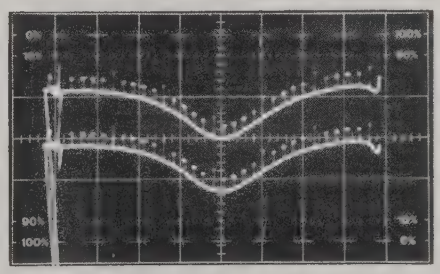


Fig. 2.7 Alternate sweeps displaced by 0.25 dB

2.5 MARKERS

Markers are produced, either from an internal oscillator or from an external r.f. source and are available at the MARKER OUTPUT socket for direct connection to the display device.

It is usually more convenient to add the markers to the detected sweep waveform before connection to the display device. To do this,

connect the equipment as in Fig. 2.3 and set the controls to display the response of the unit under test.

An alternative way of displaying markers is to use them to intensity modulate an oscilloscope trace. A direct connection between the MARKER OUTPUT socket and the oscilloscope Z modulation input can be used, or if the oscilloscope has a low input impedance (such as TF 2210) the markers would be better taken from the COMBINED OUTPUT socket.

Internal

Internal markers are produced at 5 MHz and 1 MHz intervals, the 5 MHz markers can be recognized by their greater amplitude and by their central zero-amplitude point (visible at low sweep widths) whilst the 1 MHz markers have a simple pulse form. The traces in Fig. 2.7 show the full swept band with the zero frequency point, a 1 MHz marker 'below' it and 1 and 5 MHz markers up to 30 MHz.

Set the MARKERS selector to INTERNAL, the MARKER switch to ON and adjust the MARKER HEIGHT control for a convenient marker amplitude.

External

External markers can be produced at any frequency within the swept band corresponding to the frequency of an external oscillator. The form of the marker is a birdie with a central zero amplitude point and equal positive and negative-going excursions. If more than one frequency is fed in, or if the signal contains harmonics a separate marker will be produced corresponding to each frequency component. If the swept band passes through the zero frequency point a birdie marker is always produced.

To produce external markers, connect a video frequency oscillator or a signal generator to the EXTERNAL MARKER INPUT socket, set the MARKERS selector to EXTERNAL and the MARKER switch to ON. Adjust the oscillator output level and the MARKER HEIGHT control to give a convenient marker amplitude. If the sweep width is low, set the EXTERNAL MARKER BANDWIDTH switch to NARROW to reduce the width of the marker on the display.

External markers can be displayed together with the internally generated markers by setting the MARKERS selector to INTERNAL + EXTERNAL.

Marker display on steep slopes

The testing of circuits where the output is a waveform having a steep slope can present problems of accurate frequency identification, because the angle between a marker and the slope is small, and the exact location of the marker ill-defined (Fig. 2.8).

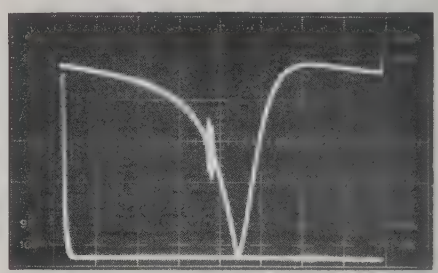


Fig. 2.8 Vertical marker on steep slope

To overcome this, the markers can be added to the X-drive and adjusted so that they are at right-angles to the slope (Fig. 2.9). The markers shown in the illustrations are derived from an external c.w. signal and appear as birdie type, thereby defining the centre point of the marker. Internal markers can, of course, also be used.

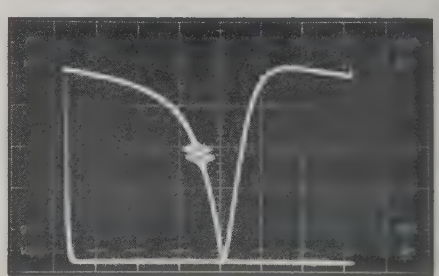


Fig. 2.9 Tilted marker on steep slope

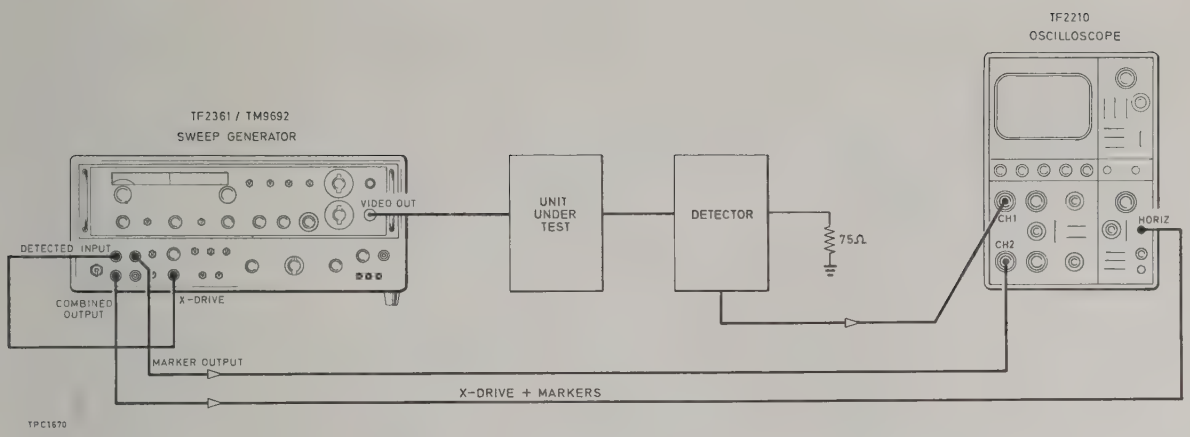


Fig. 2.10 Connections to produce tilted markers

To produce tilted markers, connect the equipment as in Fig. 2.10. With the two vertical inputs to an oscilloscope in the ADD 1 + 2 mode, adjustment of the marker angle can be produced by varying the gain of the oscilloscope channel carrying the markers.

Marker display on video sweep

Whilst markers can be added to the detected sweep envelope from the unit under test, it is sometimes useful to see markers displayed directly on the video sweep, provided that the oscilloscope used has a bandwidth that is capable of viewing the r.f.

To achieve this effect, the video a.l.c. detector TM 9704 is used as a convenient means of adding the markers. Make connections as shown in Fig. 2.11.

Under these conditions the flatness is not impaired and the markers are discernible but improved definition can be obtained by attenuating the video output. The markers appear as part of the trace instead of being superimposed upon it.

2.6 EXTERNALLY LOCKED SWEEPS

To obtain a sweep locked to frequency of the a.c. supply connected to the instrument, turn the SWEEP FUNCTION switch to MAINS LOCK.

To obtain a sweep locked to the frame sync of a television signal, turn the SWEEP FUNCTION switch to TV and connect the reference signal to the EXTERNAL DRIVE INPUT socket. A sync separator circuit is fitted to the instrument and so locking is possible to a composite video signal, negative-going field pulses or to a sine wave; for the levels required see Data Summary, Sect. 1.2.

With either mains or TV lock the start of the sweep is locked to the supply or television waveform but the VARIABLE RATE control still functions and can be used (within its range) to alter

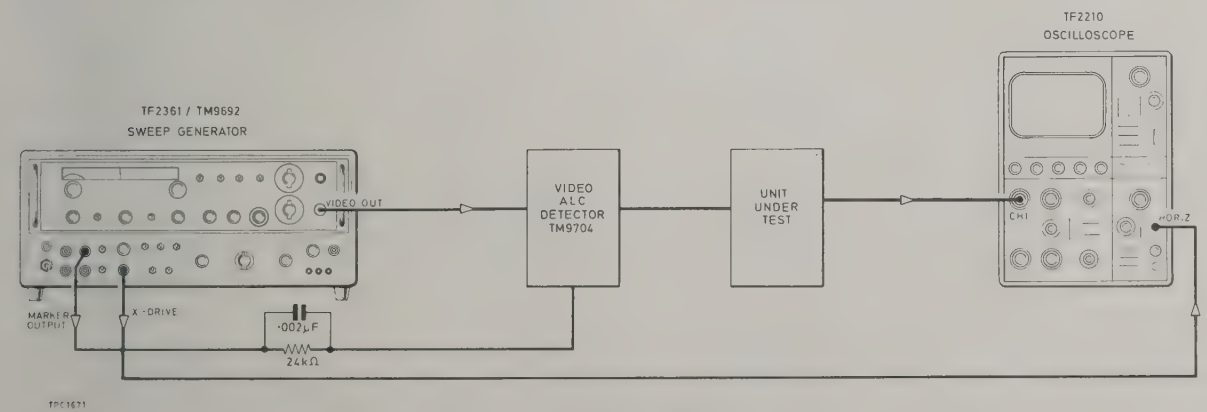


Fig. 2.11 Connections for marker display on video sweep

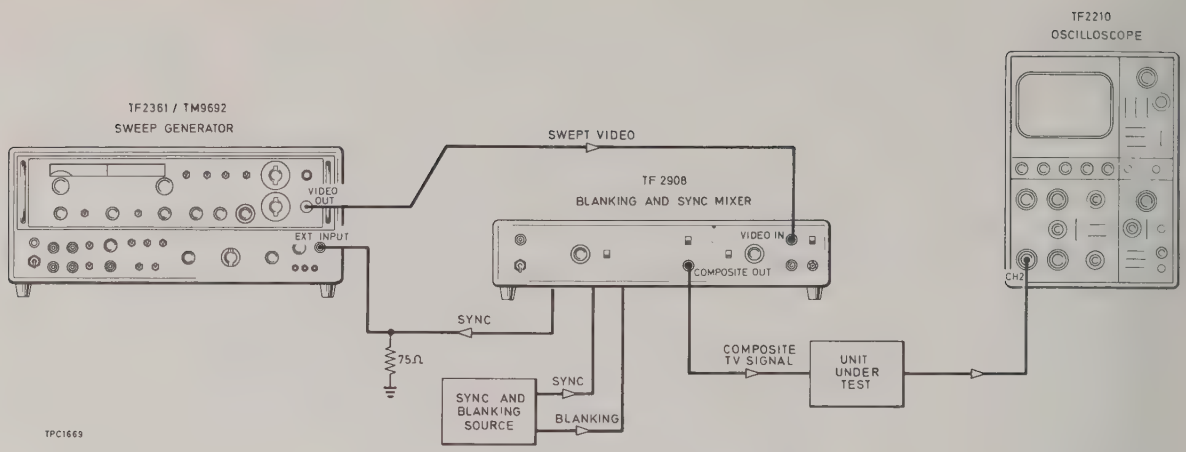


Fig. 2.12 Connections for swept video on composite television waveform

the sweep speed. At high sweep speeds the sweep finishes and waits for the arrival of the next locking impulse. As the sweep speed is reduced the waiting time falls; when it has fallen below about 500 μs unstable locking may be experienced; when the waiting time has fallen below zero the sweep will lock in a stable fashion on alternate locking impulses.

All the other controls and facilities of the sweep generator apply as for the internal repetitive sweeps.

Phase shift

In either the mains or TV lock mode the phase relationship between the locking impulse and the start of the sweep can be altered by up to 270 ^{o} using the PHASE SHIFT control. An example of the need to use phase shift occurs when it is desired to add swept video to a composite television signal.

To produce a composite television signal with swept video a source of sync and blanking signals is required and also a Sync and Blanking Mixer TF 2908. Make connections as shown in Fig. 2.12.

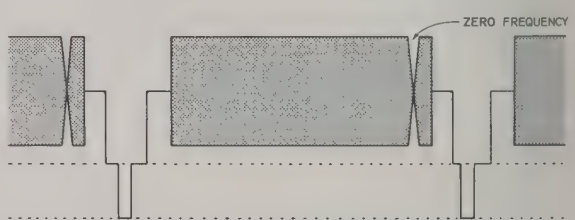
The oscilloscope is used with its own time base for the horizontal deflection, internally triggered. Fig. 2.13 shows the resultant waveform, at frame period, with the RATIO switch at 10:1; if a 1:1 ratio is used the amount of the frame period occupied by the swept video is approximately halved. It is often required to see the effect of the video signal immediately following the field blanking; by adjustment of the PHASE SHIFT control, either the high frequency end or the low frequency end of the sweep can be positioned at this point.

2.7 EXTERNAL SWEEP

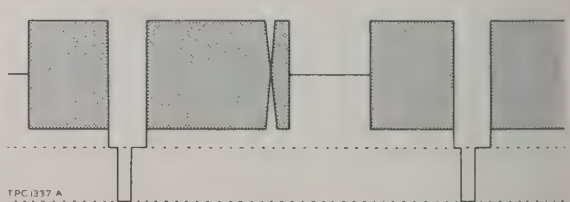
The sweep circuits can be driven by an externally produced signal which may be a ramp, sine wave or other waveform. The frequency response extends from d.c. to 20 kHz.

(1) Connect the external signal to the EXTERNAL DRIVE INPUT socket.

(2) With the SWEEP FUNCTION switch at 10 - 100 Hz measure, preferably using an oscilloscope, the peak-to-peak amplitude of the sweep drive at the SWEEP DRIVE MONITOR socket.



Video sweep centred in field period, ratio 10:1



Video sweep delayed about 200 degrees, ratio 10:1

Fig. 2.13 Effect of altering phase shift

(3) Turn the SWEEP FUNCTION switch to EXTERNAL and adjust the EXTERNAL DRIVE SET LEVEL control so that the sweep drive amplitude is the same as previously measured.

(4) The sweep width controls can now be used as for internal sweeps and the calibration will give the total swept excursion. The centre frequency controls also function, but the calibration only applies if the input waveform is a ramp.

The sweep waveform and the X-drive waveform will follow that of the input provided that the SWEEP LINEARITY switch is at LINEAR. The normal facilities of external and internal a.l.c., external and internal markers, and fine level adjustment are available but blanking is not provided, nor is the alternate sweep facility.

2.8 MANUAL SWEEP

With the SWEEP FUNCTION switch at MANUAL the output frequency is determined by the VARIABLE RATE (MANUAL) control, within the limits set up by the SWEEP WIDTH and CENTRE FREQUENCY controls. A corresponding X-drive signal is available, as well as external and internal a.l.c., external and internal markers, and fine level adjustment; but blanking is not provided nor is the alternate sweep facility.

2.9 C.W.

With the SWEEP FUNCTION switch at C.W. the generator functions as a simple oscillator. The frequency is determined by the settings of the CENTRE FREQUENCY controls.

2.10 ONE SHOT

On all the internally generated sweep ranges, including TV and mains lock, it is possible to set the generator to operate in the 'one shot' mode, i.e. to perform one sweep and then stop. To achieve this, set the SWEEP MODE switch to ONE SHOT, press the ONE SHOT switch down and then release it; the switch is spring loaded and, as it returns to the upper position, the sweep will be initiated.

When the 'one shot' mode is selected the generator will complete the sweep being made, before the single shot can be initiated. This fact is of little consequence at the higher sweep rates but at the lower rates a waiting time of up to 100 seconds could be required. To avoid this, turn the SWEEP FUNCTION switch to the highest sweep rate and then back to the desired low rate after the 'one shot' mode has been selected.

Decibel conversion table

Ratio Down			Ratio Up	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·7943	·6310	**2·0**	1·259	1·585
·7079	·5012	**3·0**	1·413	1·995
·6310	·3981	**4·0**	1·585	2·512
·5623	·3162	**5·0**	1·778	3·162
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	$6{\cdot}310 \times 10^{-3}$	**22**	12·59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	**24**	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	**26**	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	**28**	25·12	631·0
·03162	$1{\cdot}000 \times 10^{-3}$	**30**	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	**32**	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	**34**	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	**36**	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1{\cdot}585 \times 10^{-4}$	**38**	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	**40**	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	**42**	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3{\cdot}981 \times 10^{-5}$	**44**	158·5	$2{\cdot}512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	**46**	199·5	$3{\cdot}981 \times 10^{4}$
$3{\cdot}981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	**48**	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	**50**	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	**60**	1,000	$1{\cdot}000 \times 10^{6}$

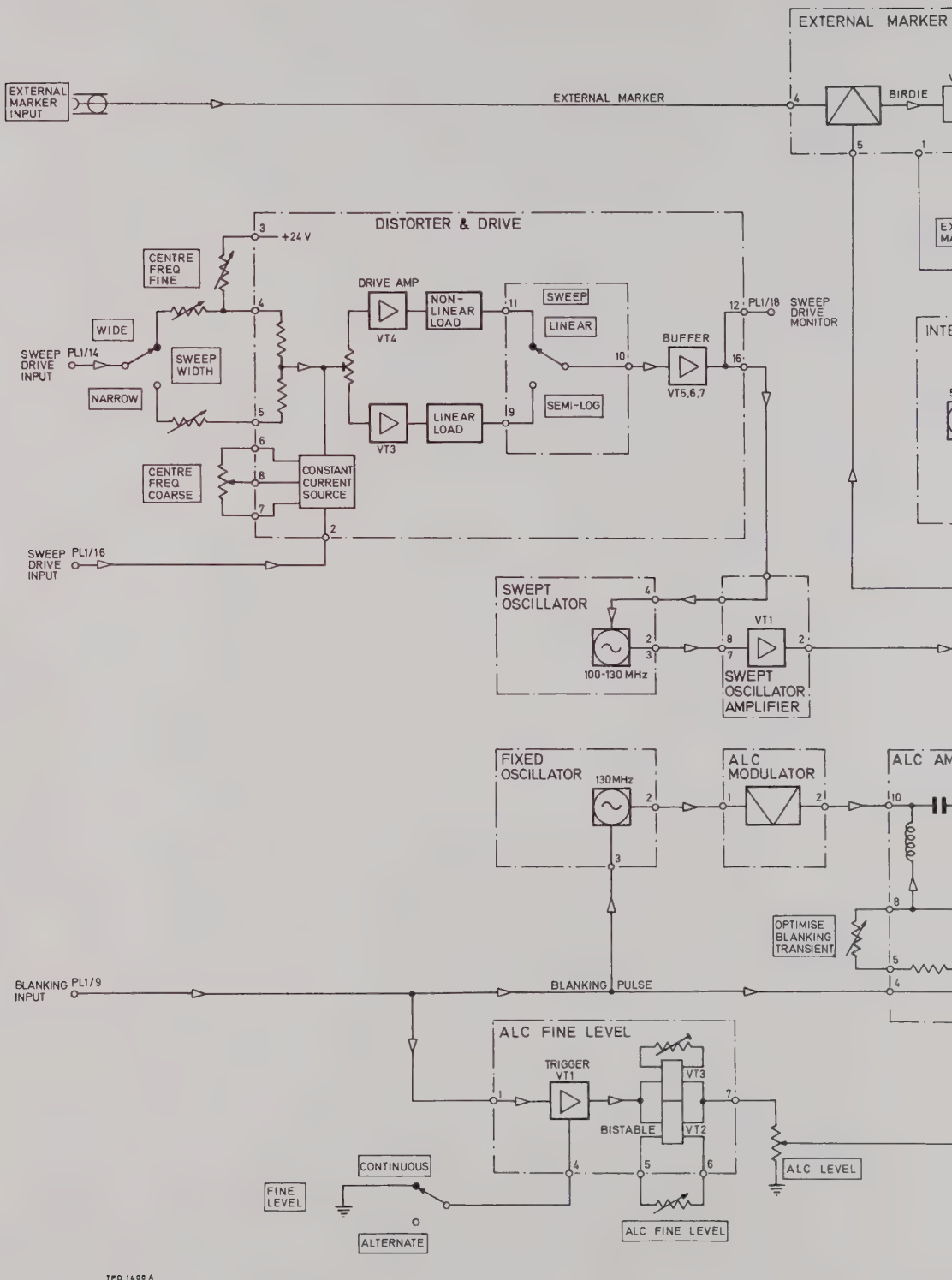
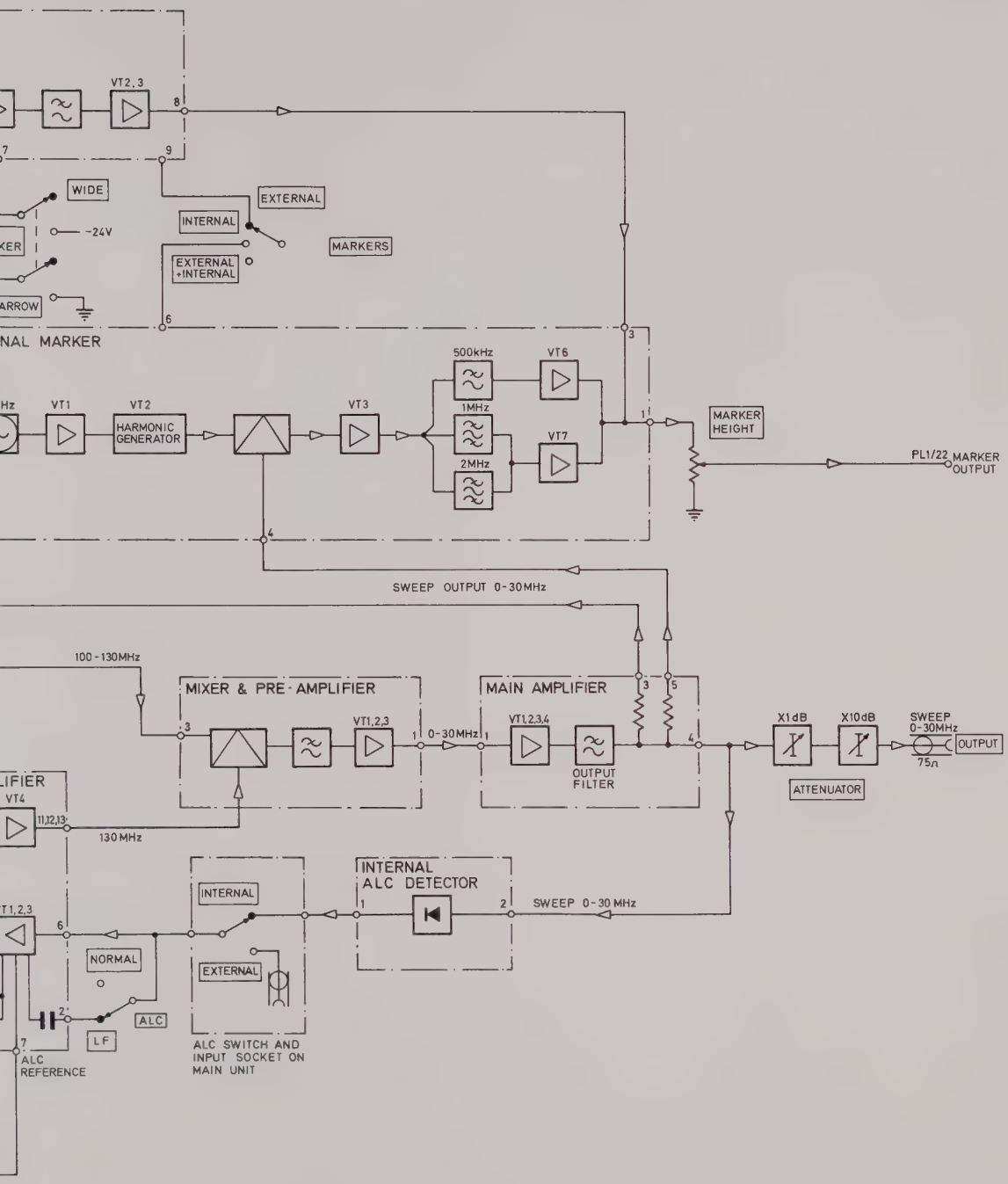


Fig. 3.1 Block diagram


VT2, 3
WIDE
-24V
EXTERNAL
INTERNAL
EXTERNAL +INTERNAL
MARKERS
NAL MARKER
500kHz
VT6
1MHz
VT7
2MHz
VT1
VT2
HARMONIC GENERATOR
VT3
MARKER HEIGHT
PL1/22 MARKER OUTPUT
SWEEP OUTPUT 0-30MHz
100-130MHz
MIXER & PRE-AMPLIFIER
VT1,2,3
0-30MHz
MAIN AMPLIFIER
VT1,2,3,4
OUTPUT FILTER
X1dB
X10dB
SWEEP 0-30MHz
OUTPUT
75Ω
ATTENUATOR
VT4
11,12,13
130 MHz
INTERNAL ALC DETECTOR
SWEEP 0-30 MHz
INTERNAL
NORMAL
EXTERNAL
ALC
LF
ALC REFERENCE
ALC SWITCH AND INPUT SOCKET ON MAIN UNIT

Chapter 3

Technical description

3.1 GENERAL

The following technical description should be read in conjunction with the block diagram Fig. 3.1 and the circuit diagrams included at the end of this manual.

The frequency-swept output signal is obtained by mixing the outputs from a swept oscillator operating between 100 MHz and 130 MHz, and a fixed oscillator operating at 130 MHz. The difference frequency is used to provide an output of 1 V r.m.s. into 75 Ω swept from 0 to 30 MHz at maximum sweep width. A mechanical interlock between the sweep width and centre frequency controls restricts the sweep width at centre frequencies other than 15 MHz, and prevents the sweep from extending more than approximately 1.5 MHz beyond zero or above approximately 31.5 MHz. Provision is made for either linear or semi-logarithmic sweeps, the latter being used to give expansion at the lower end of the frequency range.

All power supplies and the sweep drive are obtained from the main unit via the 24-pin plug-in connector. The sweep drive, in the form of a linear current ramp, is applied to the distorter and drive circuit, where control circuits are provided for control of sweep width and centre frequency, and for linear or semi-log operation. The distorter section of the circuit compensates for the non-linearity of the varactors used for varying the frequency of the swept oscillator. The output from the swept oscillator is taken to a balanced mixer via an a.l.c. modulator and tuned amplifier.

The difference frequency from the balanced mixer is applied to a low-pass filter and pre-amplifier before being fed to the push-pull main amplifier. An additional low-pass filter removes unwanted frequencies above the maximum output frequency, caused by harmonics in the main amplifier.

The output to the attenuators is monitored by a negative p-p a.l.c. detector, and the detected signal compared with a reference voltage to provide an error signal for the a.l.c. system. The error signal is fed through an a.l.c. amplifier and used to control the a.l.c. modulator. The reference voltage for the a.l.c. system can be adjusted to vary the output level, by means of a calibrated ±1 dB fine level control, and this variation can be applied to every sweep or to alternate sweeps only. Provision is made to to switch in a longer a.l.c. time constant when working at frequencies below 1 MHz, to give less distortion at this end of the range.

Flyback suppression can be switched in when required, and is effected by applying the blanking signal from the main unit to the 130 MHz fixed oscillator. The blanking signal inhibits the oscillator during the flyback period.

Two marker circuits are provided, for internal and external markers. The internal marker circuit mixes part of the sweep output with the fundamental frequency and harmonics of a 5 MHz crystal oscillator, and produces a positive-going rectified birdie marker at every 5 MHz interval with a positive pulse marker at every intervening 1 MHz interval. The external marker circuit mixes part of the sweep output with an externally generated c.w. signal, and produces a positive and negative-going birdie marker at the point corresponding to the frequency of the external signal. The external markers can be set to wide or narrow, both external and internal markers can be adjusted in amplitude by a single height control, and a selector switch permits the display of either external or internal markers, or both combined.

3.2 DISTORTER AND DRIVE CIRCUIT

Circuit diagram—Fig. 7.1

The distorter and drive circuit (board 22) provides a voltage swing in excess of 60 V to vary the frequency of the swept oscillator. The shape of the output waveform depends on the position of the linear - semi-log switch, being concave in the linear position and linear in the semi-log position.

A current source VT2 provides a steady bias current which is divided between VT3 and VT4 via the preset equalizing control RV9. The sweep drive from the main unit in the form of a current ramp is fed into the collector circuit of VT1, and into the collector circuit of VT2 via the sweep width switch and the wide and narrow controls RV1 or RV2. The centre frequency control circuit with RV7 and RV8 (RV8 is the zero setting preset

control) varies the bias on the base of VT2, while fine centre frequency control is effected by RV4 varying the bias to the sweep width control circuit.

With the sweep width control set to maximum, all the sweep drive current is applied to the collector of VT2, so that maximum voltage swing is obtained at the output of VT2 and the swept oscillator frequency varies from 100 to 130 MHz. With the sweep width control set to minimum the drive current is reduced to zero, and the swept oscillator produces a fixed frequency determined by the setting of the centre frequency controls.

MR4 in the common bases of VT3 and VT4 provides temperature compensation for the transistor base-emitter junctions. MR1, MR2 and MR3 are also temperature compensating diodes, for the constant current source and the centre frequency control circuit. The value of the resistor R8 is selected on test so that a small current is fed to the base of VT2 to compensate for circuit non-linearities, and in particular to establish that the centre frequency control RV7 has an equal swing for frequencies between 0 and 15 MHz and between 15 and 30 MHz.

The distorter circuit compensates for the non-linearity of the varactors used to control the frequency of the swept oscillator, and this circuit forms the collector load for VT4, while the collector load for VT3 is linear. As a result, the linear current swing through VT3 and VT4 produces a linear voltage ramp at the collector of VT3 and a shaped voltage ramp of concave form at the collector of VT4, the final shape of the curve for the linear sweep being obtained from a combination of these two collector outputs. Several preset controls are provided in this circuit: RV14 for fine adjustment of linearity, RV6 and RV11 for setting the zero and 30 MHz limits of the semi-log sweep, and RV15 for setting the output level.

The distorter comprises a ladder circuit having 12 diodes, MR5 to MR16, shunt connected to progressively increasing voltage tappings on a resistor chain. As the current through the load increases, so does the voltage across it and consequently more diodes conduct, thus reducing the load impedance. In this way, the ideal curve is closely matched by thirteen linear increments. The preset controls RV12 and RV13 provide slope adjustment at the critical low-voltage end of the ramp.

VT5 and VT6 act as buffers between the high impedance outputs of VT3 and VT4 and the sweep output circuit comprising VT7 and the level setting preset control. MR17 provides temperature compensation, and a connection from the collector of VT7 is taken to the sweep drive monitor socket on the front panel of the main unit.

3.3 SWEPT OSCILLATOR

Circuit diagram—Fig. 7.1

The swept oscillator (board 20) is a Hartley circuit with the feedback path taken from the tapped inductor L3 to the base of VT1.

Tuning is effected by a combination of the stray capacitance and the capacitance of the four varactor diodes MR1 to MR4 connected in series-parallel. This arrangement reduces distortion in the oscillator to a minimum, because no change in total capacitance is caused by any r.f. voltage across the diodes, since an increase in capacitance across one pair of diodes will be balanced by a corresponding decrease across the other pair. The frequency control voltage from the distorter and drive unit is applied to the centre point of the diode configuration, so that the control voltage across each pair of diodes is the same.

The swept oscillator output is taken from the loop L4 coupled to L3, the loop being printed on the underside of board 20 and broadly tuned at about 100 MHz to give maximum drive to the mixer at the upper output frequencies.

3.4 SWEPT OSCILLATOR AMPLIFIER

Circuit diagram—Fig. 7.1

The swept oscillator amplifier (board 16) comprises a single transistor VT1 which receives a 30 mV r.f. signal input from the loop L4 on board 20. The amplifier output is about 500 mV r.m.s., and is applied to one input of the ring mixer.

3.5 FIXED OSCILLATOR

Circuit diagram—Fig. 7.2

The fixed oscillator (board 21) is a Hartley circuit similar to that used for the swept oscillator, except that the varactor diodes are replaced by a single trimmer capacitor and the tuning inductor L1 has one extra turn. The output is taken from a coupling loop L2 printed on the underside of the board.

The d.c. supply for the oscillator circuit is obtained from the output of the blanking generator on the main unit via pin 9 of the 24-way connector. With blanking switched off the supply is a steady +22 V, but with blanking switched on the supply is a pulse waveform going to 0 V during the flyback period. The oscillator is then inhibited to give flyback blanking.

3.6 A.L.C. MODULATOR

Circuit diagram—Fig. 7.2

The a.l.c. modulator (board 15) comprises a diode-resistor ladder which presents a varying degree of attenuation to the passage of the r.f. signal from the fixed oscillator, the variation being effected by the d.c. signal from the a.l.c. amplifier, which appears on pin 2. The r.f. output from pin 2 is taken to the tuned amplifier on the a.l.c. amplifier board. Under normal conditions of operation attenuation presented by the modulator covers a range of a few dB, but up to 24 dB is available.

3.7 A.L.C. AMPLIFIER

Circuit diagram—Fig. 7.2

The a.l.c. amplifier (board 18) comprises two circuits, one being a tuned amplifier passing the 130 MHz fixed oscillator signal from the a.l.c. modulator to the mixer and pre-amplifier, the other a d.c. amplifier and control circuit for the a.l.c. signal.

The tuned amplifier comprises VT4, L2 and the preset variable capacitor C15 in a high Q circuit, tuned to reduce noise and reject harmonics. The output to the mixer is taken from the coupling coil L3.

The a.l.c. amplifier comprises an input stage followed by two stages of amplification. The whole amplifier has capacitive negative feedback from input to output, producing a Miller integrator effect with a time constant that can be varied by adjusting the feedback capacitance. Adjustment is made by the a.l.c. bandwidth switch, the l.f. position being used to increase the time constant to give less distortion at frequencies below 1 MHz.

Four inputs are applied to the input stage: the a.l.c. error signal from the internal a.l.c. detector or from an external source; a d.c. reference signal from the a.l.c. fine level circuit, giving fine and coarse level control and application of this control on every sweep or alternate sweeps; an overall feedback signal from the amplifier output via the optimize blanking transient control; and a blanking signal from the main unit.

The optimize blanking transient feedback signal is only applied during the flyback period, to maintain the amplifier at its normal operating conditions and prevent it bottoming during this period. This prevents the time constant causing a delay in recovery when the sweep restarts, with consequent instability of operation. The control should be adjusted to minimize the r.f. transient at the start of each sweep.

Some phase advance is included in the circuit where the fine level control is applied, to give higher loop stability. The a.l.c. amplifier has an inherently high loop gain to maintain a flat response over the full sweep width from 25 kHz to 30 MHz.

The output of the a.l.c. amplifier is taken to the a.l.c. modulator via the r.f. choke L1, which isolates the amplifier from the 130 MHz signal, and the r.f. section VT4 is isolated from the a.l.c. signal by C12.

3.8 MIXER AND PRE-AMPLIFIER

Circuit diagram—Fig. 7.2

The mixer and pre-amplifier (board 17) comprises a ring bridge mixer followed by a wide-band amplifier. The mixer is supplied with the 100 to 130 MHz signal from the swept oscillator via the ferrite cored adjustable coupling transformer T1, and with the 130 MHz signal from the fixed oscillator via the centre-tapped coupling coil L3 on board 18. The difference frequency, 0 to 30 MHz, is taken from the centre tap on this coupling coil and returns via pin 6 to form the input to the pre-amplifier. L1 and L2, with preset capacitor C14, is a low-pass filter to remove harmonics.

The pre-amplifier is a conventional three-stage circuit with negative feedback between stages, and with some high frequency compensation between stages 1 and 2 and in the output. The amplifier output, at approximately 150 mV r.m.s., is fed to the main amplifier.

3.9 MAIN AMPLIFIER AND OUTPUT FILTER

Circuit diagram—Fig. 7.2

The main amplifier (board 19) has the input from the pre-amplifier connected to VT1, which forms one half of a d.c. stabilized phase-splitting circuit. The two outputs from the phase splitter feed the push-pull output stage VT3 and VT4; this stage has a large measure of negative feedback from the collector to base of each transistor, with a preset balancing control RV1 in the emitter circuit.

The push-pull output transformer T1 has a ferrite toroidal core and is trifilar wound with the

three wires forming the two halves of the primary and the secondary, to ensure tight coupling and an exact centre tap.

The output from the transformer is taken to a low-pass filter which removes harmonics above the maximum output frequency. The filter cuts off at 41 MHz, which is far enough away from 30 MHz to avoid the introduction of a phase shift component. The filter output is connected to the output attenuators, the a.l.c. circuit, and the internal and external marker circuits.

3.10 INTERNAL A.L.C. DETECTOR

Circuit diagram—Fig. 7.2

The internal a.l.c. detector (board 14) receives its input from the main amplifier via a preset control RV1, which is used to compensate for differences in frequency response between the detector circuit and the output attenuators. The conventional p-p detector circuit is followed by a series resistor to prevent any r.f. in the d.c. output lead being reflected back and causing distortion of the frequency response characteristic. Because load variations cause no change in level at the internal a.l.c. detector, this point is effectively a zero impedance source. Hence a 75 Ω series resistor is included to define the output impedance.

The detector output is taken to the input of the a.l.c. amplifier via the a.l.c. switch on the main unit.

3.11 FINE LEVEL

Circuit diagram—Fig. 7.2

The a.l.c. fine level circuit (board 12) produces a direct voltage which is used to establish the bias on the emitter of the input stage VT1 in the a.l.c. amplifier, thus effectively controlling the reference voltage with which the internal a.l.c. detector output is compared.

In the fine level circuit, provision is made to vary the a.l.c. level by ±1 dB with a calibrated front panel control, and to switch the fine level control so that it either operates on every sweep or on alternate sweeps.

A reference voltage is developed across the common emitter load of the bistable VT2 and VT3, and the current through VT2 is preset by RV1 and RV2. The current through VT3 is adjusted by the ±1 dB fine level control. With the fine level selector set to continuous position, VT3 is switched on permanently because the base of VT2 is at earth potential to a.c., but when this switch is put to alternate, VT3 is released from earth and the blanking signal can then trigger the bistable. The blanking signal is differentiated by R1 and C1 and inverted by VT1, and its effect on the bistable is to switch VT3 on and off with each consecutive blanking pulse. The a.l.c. level output signal is then at the level determined by the fine level control for one sweep, followed by the level determined by the steady current through VT2 for the next sweep. In this way, a double trace can be produced on an oscilloscope for precise measurement of the flatness of a frequency response characteristic.

The three preset potentiometers are used to set the absolute level (RV1), the fixed level relative to the variable level (RV2) and the range of the fine level control (RV3). The output is taken through the front panel a.l.c. level control, but this is not intended to control the level of the internal a.l.c.; it is only for controlling the level of the external a.l.c., and should be in the fully clockwise position when the a.l.c. switch is set to internal.

3.12 INTERNAL MARKERS

Circuit diagram—Fig. 7.3

The internal marker circuit (board 23) has a crystal controlled Colpitts oscillator VT1 operating at 5 MHz, followed by a harmonic generator VT2 which distorts the 5 MHz sine wave to give harmonics up to at least the sixth (30 MHz). The output of VT2 passes through the secondary of the transformer T1, while the primary receives a part of the sweep output from the main amplifier. MR2 and MR3 form a different detector circuit and the input to the amplifier VT3 is therefore the difference frequency between the sweep frequency and the c.w. signals produced at 5 MHz intervals by the harmonic generator.

In the sweep range 2.5 to 7.5 MHz, for example, the difference signal starts at 2.5 MHz, passes through zero at 5 MHz, and then rises again to 2.5 MHz. Frequencies above 2.5 MHz are rejected by the filter L1 and C8, so that over the 0 to 30 MHz range of the sweep output a recurring frequency cycle is produced reaching a maximum frequency of 2.5 MHz and dropping to zero at each 5 MHz interval (see Fig. 3.2).

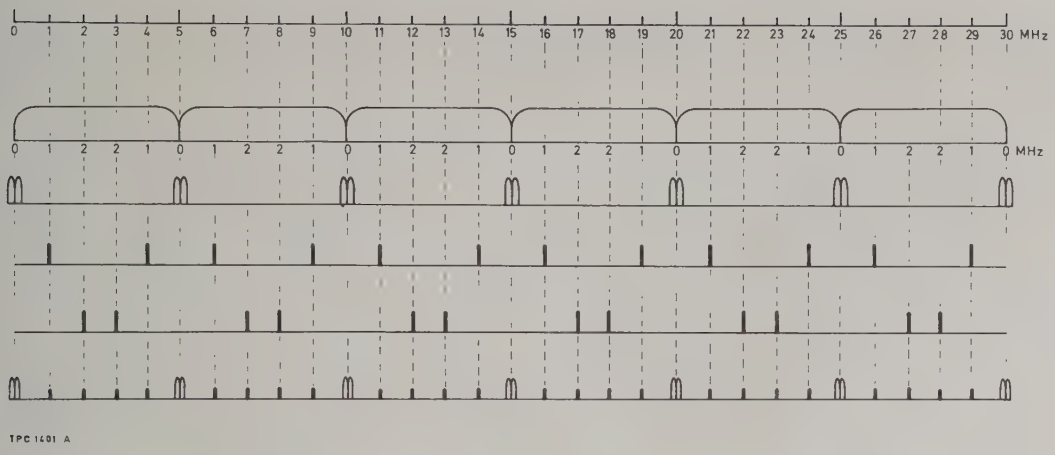


Fig. 3.2 Internal marker generation

Direct breakthrough of the sweep below 2.5 MHz will cause a similar effect at 0 MHz. The difference frequency cycles are equalized in amplitude by the clipping amplifier stage with MR4 and MR5, followed by the amplifying stage VT5.

The difference signal is used to produce both the 5 MHz markers and the intervening 1 MHz markers, as follows:

(a) The filter circuit C13 and R19 passes only frequencies below 500 kHz, which occur on either side of each 5 MHz interval; the result is a birdie marker, with a peak on either side of the zero point which is centred on a 5 MHz interval (see Fig. 3.2).

(b) The filter C19, C20 and L3 is a resonant circuit tuned to 1 MHz, which passes a peak every time the difference signal passes through 1 MHz; in this way markers are produced at 1 MHz, 4 MHz, 6 MHz, 9 MHz and so on.

(c) The filter C17, C18 and L2 is a similar resonant circuit tuned to 2 MHz, thus producing markers in the intervening 1 MHz intervals, i.e. at 2 MHz, 3 MHz, 7 MHz, 8 MHz up to 27 MHz and 28 MHz.

The 5 MHz birdie markers are set in amplitude by the preset control RV1 and applied to the base of VT6, which passes only the negative-going half of the birdie to the marker output circuit. MR6 protects the base-emitter junction of VT6 against the positive-going half of the birdie. The 1 MHz and 2 MHz filters are in series, and these markers are applied to the base of VT7 via the preset amplitude control RV2. VT7 passes negative-going marker pulses, and all the markers are then mixed on the common collector loads of VT6 and VT7 to produce the positive internal marker output. This is mixed with the external marker output, passed through the front panel marker height control, and taken to the marker adder circuit and output socket on the main unit via pin 22 of the 24-way connector.

When the marker selector switch is set to external, the internal markers are turned off by removing the +24 V supply from part of the circuit.

3.13 EXTERNAL MARKERS

Circuit diagram—Fig. 7.3

The external marker circuit (board 13) receives part of the sweep output from the main amplifier, and an input from the external marker input socket on the front panel. These two inputs are applied to the difference detector MR1 and MR2, which produces a zero beat when the external c.w. signal coincides with the sweep frequency. The result is a birdie marker with a peak at either side of the c.w. signal frequency, which is passed through the emitter follower stage VT1 to feed the low-pass filter network L1, L2, C3 and MR3. This filter circuit restricts the bandwidth of the birdie marker in conjunction with the marker bandwidth switch; when this switch is in the wide position, the marker is sufficiently wide to be seen at high sweep speeds or over a wide sweep width, but this would be too wide at the lower end of the frequency band, down to 25 kHz. With the switch set to narrow, MR3 and MR4 are switched into conduction and additional capacitance inserted in the filter network to reduce the bandwidth.

At the same time the low frequency response of the amplifier VT2 is improved to maintain the normal marker height.

The resistors R19 and R20 isolate the internal marker output from the capacitive loading of C11, and from the earth connection applied via terminal 9 when the marker selector switch is set to internal markers only. The output, which is a birdie marker with equal positive and negative-going excursions, is taken via the marker height control to the marker adder circuit on the main unit.

The external marker circuit can be used to produce more than one marker if the applied c.w. signal contains harmonics, since a birdie marker will then be produced at each harmonic frequency.

3.14 OUTPUT ATTENUATORS

Circuit diagram—Fig. 7.4

The two output attenuators (boards 24 and 25) give a total of 61 dB attenuation in eleven steps of 1 dB on one attenuator and five steps of 10 dB on the other. Each attenuator is a ladder network designed for operation from a 75 Ω source into a 75 Ω load. The output from the x10 dB attenuator is taken to the front panel output socket.

3.15 POWER SUPPLIES

All power supplies are received from the main unit via the 24-way connector, pin 1 (+24 V), pin 5 (-24 V) and pin 3 (+110 V). The +110 V supply is only used for the distorter and drive unit, while the ±24 V supplies are used on all the main boards.

Chapter 4

Maintenance

4.1 INTRODUCTION

This chapter contains information for keeping the equipment in good working order and for checking its performance.

Test equipment required

This section provides a list of the test equipment that will be required to carry out the performance checks detailed in this chapter.

a) Oscilloscope, such as M.I. TF 2201 or TF 2210.

b) Signal generator, 500 kHz to 30 MHz, such as Marconi TF 144H. SG503

c) Video detector, Marconi TM 9703.*

d) 75 Ω termination, GE 40081/75.* —use Wiltron std.

* Accessories supplied with instrument.

4.2 INITIAL CONDITIONS

Performance faults in the main unit are likely to invalidate any performance checks on the sweep unit, and it is therefore essential that the main unit should be checked first. For the following checks, the sweep unit should be fitted in the main unit, with the complete instrument in its case.

Set the front panel controls to the following positions:

(A) Main unit

SUPPLY switch to ON.

SWEEP FUNCTION switch at 10 - 100 Hz.

VARIABLE RATE control to mid-position.

RATIO switch at 1:1.

SWEEP MODE switch at NORMAL.

BLANKING switch ON.

A. L. C. switch at INTERNAL.

MARKER switch ON.

~~X-DRIVE LEVEL~~

X-DRIVE LEVEL control fully counter-clockwise.

X-DRIVE switch at ~~FORWARD~~. REV

(B) Video sweep unit

SWEEP WIDTH control fully clockwise.

SWEEP WIDTH SELECTOR at WIDE.

OPTIMIZE BLANKING TRANSIENT control at mid-position.

CENTRE FREQUENCY control to give 15 MHz on scale.

FINE CENTRE FREQUENCY control at mid-position.

MARKER HEIGHT control at mid-position.

SWEEP LINEARITY switch at LINEAR.

MARKERS switch at INTERNAL.

EXT MARKER BANDWIDTH switch at WIDE.

A. L. C. BANDWIDTH switch at NORMAL.

FINE LEVEL SELECTOR at CONTINUOUS.

A. L. C. LEVEL control fully clockwise.

FINE LEVEL control at mid-position (0 dB).

Both ATTENUATION controls at 0 dB.

4.3 PERFORMANCE CHECKS

4.3.1 Frequency range and sweep width

Test equipment: a, c and d

(1) Connect the oscilloscope horizontal input to the X-drive output socket, and the Y input to the COMBINED OUTPUT socket. Connect the video

detector (switched to NORMAL) to the output socket on the sweep unit and terminate it with the 75 Ω termination. Switch the supply ON.

(2) Set the oscilloscope sensitivity to 0.5 V/cm and adjust the X-DRIVE LEVEL control so that the displayed waveform just fills the graticule. Adjust the OPTIMIZE BLANKING TRANSIENT control if necessary.

(3) Check that the zero break and the 30 MHz marker are visible on the display, as shown in Fig. 4.1.

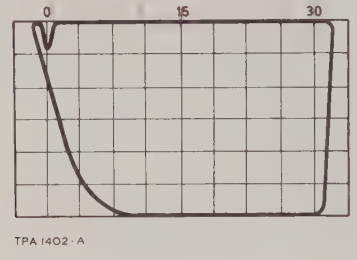


Fig. 4.1 Display for frequency range check

(4) Turn the SWEEP WIDTH control fully counter-clockwise, and check that the displayed sweep width reduces progressively to zero centred on 15 MHz.

(5) Adjust the SWEEP WIDTH control fully clockwise, and check that markers are evenly positioned over the total width of the display.

(6) Adjust the SWEEP WIDTH and CENTRE FREQUENCY controls to set the zero break and 30 MHz markers on the left-hand and right-hand edges of the graticule respectively. Check that the reading on the sweep width dial is 30 MHz ±2.5 MHz.

(7) Reduce the sweep width until the 5 MHz and 25 MHz markers are displayed on the edges of the graticule, and check that the sweep width dial reading is 20 MHz ±2 MHz.

(8) Reduce the sweep width until the 10 MHz and 20 MHz markers are displayed on the edges of the graticule, and check that the sweep width dial reading is 10 MHz ±1.5 MHz.

(9) Reduce the sweep width until the 14 MHz and 16 MHz markers are displayed on the edges of the graticule, and check that the sweep width dial reading is 2 MHz ±1.1 MHz.

(10) Set the SWEEP WIDTH control to maximum (fully clockwise) and the SWEEP WIDTH SELECTOR to NARROW. Check that the CENTRE FREQUENCY control can be adjusted so that any two adjacent markers are displayed near the edges of the graticule. Return the SWEEP WIDTH SELECTOR to WIDE.

4.3.2 Sweep linearity

Test equipment: a, c and d

(1) Connect the oscilloscope vertical input to the MARKER OUTPUT socket on the main unit, and set the oscilloscope time base to mains, 2 ms/cm, sensitivity 2 V/cm. Set the sweep generator FUNCTION switch to MAINS LOCK and RATIO switch to 10:1.

(2) Adjust the PHASE SHIFT control until the left-hand edge of the marker display is at the left-hand edge of the graticule, and then adjust the VARIABLE RATE control until the displayed waveform fills the graticule.

(3) Set the markers switch to INT + EXT and set the oscilloscope expansion to x5. Measure the intervals between each adjacent pair of markers from 0 to 30 MHz, using either the graticule or the time scale according to the type of oscilloscope in use. Use the oscilloscope horizontal shift control to bring each end of the display into view. Check that the ratio of the largest interval to the smallest interval does not exceed 1.5:1.

4.3.3 Centre frequency calibration and output amplitude

Test equipment: a, b, c and d

(1) Revert to the initial conditions detailed in Sect. 4.2, except for the following:

MARKERS switch at INT + EXT.

A. L. C. BANDWIDTH switch LF.

Oscilloscope vertical input connected to MARKER OUTPUT socket.

Oscilloscope sensitivity 2 V/cm.

SUPPLY switch ON.

(2) Adjust the SWEEP WIDTH control until 3 markers are displayed. Using the CENTRE

FREQUENCY control, adjust to every 1 MHz setting on the scale in turn, and check that the corresponding marker is within 0.5 MHz of the centre of the display, i.e. half the interval between 1 MHz markers.

(3) Set the SWEEP LINEARITY switch to SEMI-LOG, and adjust the CENTRE FREQUENCY control to zero on the semi-log scale. Connect the signal generator output to the EXTERNAL MARKER INPUT socket on the sweep unit, and adjust its frequency (at 300 mV p-p output amplitude) until the marker it produces is displayed in the centre of the graticule. Check that the frequency of the signal generator is less than 500 kHz.

(4) Set the CENTRE FREQUENCY control to 30 MHz and the signal generator frequency to 30 MHz; the internal 30 MHz marker will then be modified by the external 30 MHz marker. Check that this modified marker is within 3 MHz of the centre point on the graticule.

(5) Set the SWEEP LINEARITY switch to LINEAR, and adjust the CENTRE FREQUENCY and SWEEP WIDTH controls until two adjacent 1 MHz markers are 10 cm apart on the graticule.

(6) Adjust the FINE CENTRE FREQUENCY control from zero to fully counter-clockwise and check that the left-hand marker moves approximately 1.5 cm to the right. Then adjust the FINE CENTRE FREQUENCY control from zero to fully clockwise and check that the right-hand marker moves approximately 1.5 cm to the left. Return the FINE CENTRE FREQUENCY control to the zero setting.

(7) Disconnect the video detector and connect the oscilloscope vertical input to the VIDEO OUTPUT socket on the sweep unit, using a 75 Ω cable and a 75 Ω termination at the oscilloscope end of the cable.

(8) Set the oscilloscope sensitivity to 0.5 V/cm, and check that the p-p amplitude of the display near the zero break is 2.83 V (5.66 cm) ±2.5%. When making this check, the accuracy of the oscilloscope being used must be taken into account.

(9) Remove the 75 Ω termination on the oscilloscope, reconnect the 75 Ω cable, and set the oscilloscope sensitivity to 1 V/cm. Check that the p-p amplitude of the display near the zero break is double that measured in the last step, ±3%.

(10) Re-insert the 75 Ω termination on the oscilloscope. Check that the x1 dB and x10 dB attenuators function correctly, by noting the progressive reductions in level as the attenuation is increased. Adjust the oscilloscope sensitivity to maintain a readable display during this check.

4.3.4 Detected system flatness

Test equipment: a, b, c and d

(1) Reset the instrument to the initial conditions detailed in Sect. 4.2, except for the following:

FINE LEVEL control at +0.2 dB.

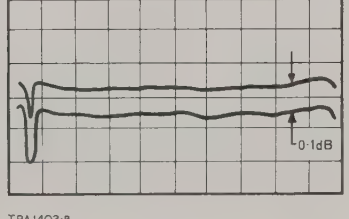
FINE LEVEL SELECTOR at ALTERNATE.

MARKER switch at OFF.

SUPPLY switch ON.

(2) Connect and set up the oscilloscope as detailed in Sect. 4.3.1 (1) and (2).

(3) Increase the oscilloscope sensitivity as far as the vertical shift allows without losing the top of the display, and check that the two traces can be positioned so that they are above and below any horizontal line of the graticule without overlap, as shown in Fig. 4.2.



TPA1403-B

Fig. 4.2 Display for detected system flatness

(4) Set the switch on the video detector unit to LF, the A.L.C. BANDWIDTH switch to LF, the MARKER switch ON, the MARKER BANDWIDTH switch to NARROW, and adjust the VARIABLE RATE control fully counter-clockwise.

(5) Adjust the SWEEP WIDTH and CENTRE FREQUENCY controls so that the zero break appears at the left-hand edge of the graticule and the 1 MHz marker at the right-hand edge of the

graticule, adjusting the OPTIMIZE BLANKING TRANSIENT control if necessary.

(6) Set up the signal generator for 100 kHz 300 mV output and connect it to the EXTERNAL MARKER INPUT socket. Set the MARKERS switch to INT + EXT, and repeat the check in paragraph (3) above.

(7) Set the SWEEP FUNCTION switch to 1 - 10 Hz, the RATIO switch to 10:1, and the SWEEP WIDTH switch to NARROW.

(8) Adjust the SWEEP WIDTH and CENTRE FREQUENCY controls so that the zero break appears at the left-hand edge of the graticule and the 100 kHz marker appears at the right-hand edge of the graticule.

(9) Reduce the signal generator frequency to 25 kHz and repeat the check in paragraph (3). The flatness must be maintained from the 25 kHz marker to the right-hand edge of the graticule.

Check only to 100kHz

(10) Put the MARKER switch OFF, disconnect the signal generator, and adjust the NARROW SWEEP WIDTH control to zero (fully counter-clockwise). Increase the oscilloscope sensitivity as far as the vertical shift allows without losing the top of the trace. Set the FINE LEVEL control to -1 dB, and check that two traces appear.

(11) Set the x1 attenuation switch to 1 dB, and align the top trace with a graticule line. Then switch the x1 attenuation control to 0 dB and adjust the FINE LEVEL control until the bottom trace is aligned with the same graticule line as the top trace. While doing this, it may be necessary to switch rapidly from 0 dB to 1 dB several times to obviate oscilloscope drift. Check that the FINE LEVEL control indicates -1 dB ±0.05 dB.

(12) Repeat for the +1 dB condition, by adjusting the FINE LEVEL control to +1 dB and aligning the bottom trace to a graticule line. Switch the attenuator between 0 and 1 dB while adjusting the FINE LEVEL control to position the top trace on the same graticule line as the bottom trace. Check that the FINE LEVEL control indicates +1 dB ±0.05 dB.

4.3.5 A.L.C. level not checked.

Test equipment: a, c and d

(1) Reset the instrument to the initial conditions detailed in Sect. 4.2.

(2) Connect and set up the oscilloscope as detailed in Sect. 4.3.1 (1) and (2).

(3) Adjust the CENTRE FREQUENCY control to zero, and adjust the OPTIMIZE BLANKING TRANSIENT control to obtain a display. Note that the zero break is ragged and unstable. Set the A.L.C. BANDWIDTH switch to LF and check that the zero break becomes stable.

(4) Set the A.L.C. BANDWIDTH switch back to NORMAL and turn the SWEEP WIDTH control fully clockwise. Set the OPTIMIZE BLANKING TRANSIENT control fully clockwise, and check that the level of the display can be reduced by means of the A.L.C. LEVEL control.

4.3.6 Internal and external markers

Test equipment: a, b, c and d

(1) Reset the instrument to the initial conditions detailed in Sect. 4.2.

(2) Connect the vertical input of the oscilloscope to the MARKER OUTPUT socket on the main unit.

(3) Set the oscilloscope sensitivity to 1 V/cm and the MARKER HEIGHT control fully clockwise. Check that the amplitude of the markers is 3.5 V ±0.6 V for 1 MHz markers and 5.3 V ±0.5 V for 5 MHz markers.

(4) Connect the signal generator output to the EXTERNAL MARKER INPUT socket, and set it for 500 mV p-p output. Set the MARKERS switch to INT + EXT, and adjust the signal generator frequency to each 1 MHz increment between 1 MHz and 30 MHz. Check that at each 1 MHz increment the signal generator marker is coincident with the appropriate internal marker. Switch off supplies and disconnect all test equipment.

Chapter 5

Repair

5.1 INTRODUCTION

This chapter contains information for adjustment or repair following failure of the instrument to pass any of the performance checks detailed in Chap. 4.

Before attempting any adjustment or repair, read the technical description given in Chap. 3.

CAUTION

This instrument uses semiconductor devices which, although having inherent long-term reliability and mechanical ruggedness, are susceptible to damage through overloading, reversed polarity and excessive heat or radiation. Avoid hazards such as reversed potentials, prolonged soldering, strong r.f. fields or other forms of radiation, use of insulation testers or accidentally applied short circuits. Even the leakage current from an unearthed soldering iron could cause trouble. Before shorting or breaking any circuit, refer to the circuit diagrams to establish the effect on bias arrangements of any associated transistors.

The performance limits quoted in this chapter are for guidance only and should not be taken as guaranteed performance specifications unless they are also quoted in the Data Summary section.

5.2 SCREW FASTENERS

Screw threads used on this equipment are of the following sizes: 8 BA, 6 BA, 4 BA and 2 BA.

Cruciform headed screws are of the Pozidriv type; to avoid damaging them a Pozidriv screwdriver should be used.

5.3 REMOVAL OF UNIT

The video sweep unit can be removed from the main unit TF 2361 by releasing the two knurled thumbscrews on the front panel and withdrawing the unit forwards out of its recess. Use slow, even pressure when engaging and disengaging the 24-way connector at the rear of the sweep unit.

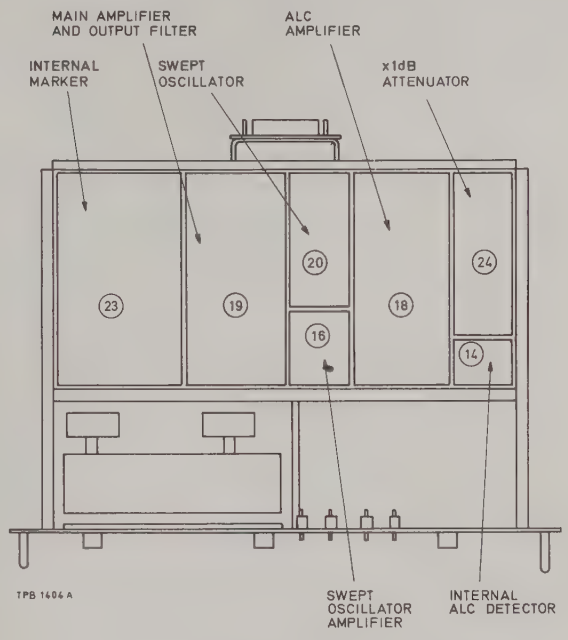


Fig. 5.1 Location of printed circuit boards, top of chassis

5.4 ACCESS TO PRINTED CIRCUIT BOARDS

The fourteen printed circuit boards are accessible from the top and underside of the plug-in chassis, and are arranged as shown in Figs. 5.1 and 5.2. Each printed circuit board is mounted in a tray, and it can be raised out of its tray for inspection or repair by removing the four 6 BA screws holding it in position; if necessary it can be completely removed by disconnecting the wired terminals which are pressed on to spigots on the board. It is possible to get a test probe on to these terminals without removing the wires, a short section of the spigot being left exposed between the board and the insulated sleeving round the terminal.

If it is found necessary to remove a printed circuit board for return to the manufacturer, it should be removed complete with its tray. Each tray is held in position by three or four 4 BA screws, one or two on a flange at the front and two at the rear.

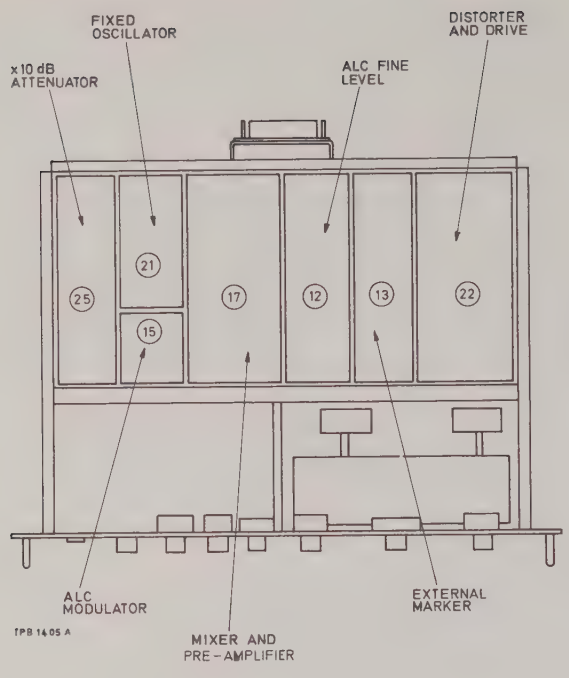


Fig. 5.2 Location of printed circuit boards, underside of chassis

CAUTION

When removing, inserting or working on printed circuit boards, take care not to bend them or to damage the printed circuit tracks on the underside of the boards. Bending can cause hair-line breaks in a track, and such breaks are very difficult to locate.

The two attenuator units are more difficult to remove, and it is recommended that they should not be removed unless absolutely essential; all components of the attenuators are reasonably accessible without removal. Do not release any of the screws within an attenuator unit, as this may upset the wafer switch settings. To remove an attenuator complete in its tray, unsolder the input and output connections, release the hexagon socket grubscrews on the drive shaft coupling, slide the coupling back until free, and remove the 4 BA screws securing the tray. These remarks also apply to board 14 (the internal a.l.c. detector), which is contained in the same tray as the x1 dB attenuator, unit 24.

All the trays containing boards, except two, are fitted with covers; the covers on the two attenuator boards are secured with four 6 BA screws, while all the other covers are of the clip-on type. To remove a clip-on cover, lever it off by inserting the blade of a small screwdriver under the lip provided for this purpose.

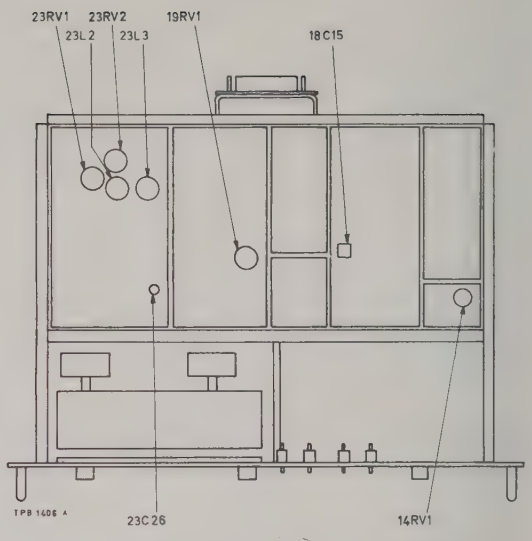


Fig. 5.3 Location of preset controls, top of chassis

5.5 ACCESS TO PRESET CONTROLS

All preset controls are mounted on the printed circuit boards accessible from the top or underside of the chassis. For the location of these controls, refer to Figs. 5.3 and 5.4.

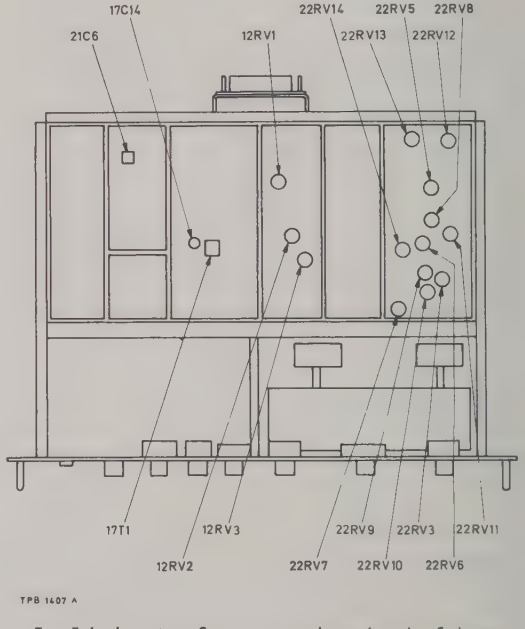


Fig. 5.4 Location of preset controls, underside of chassis

5.6 COMPONENT LOCATION

Component location diagrams are shown in Figs. 5.5 to 5.18, and these diagrams also show the location of the board terminals. For front panel components, refer to Fig. 2.1.

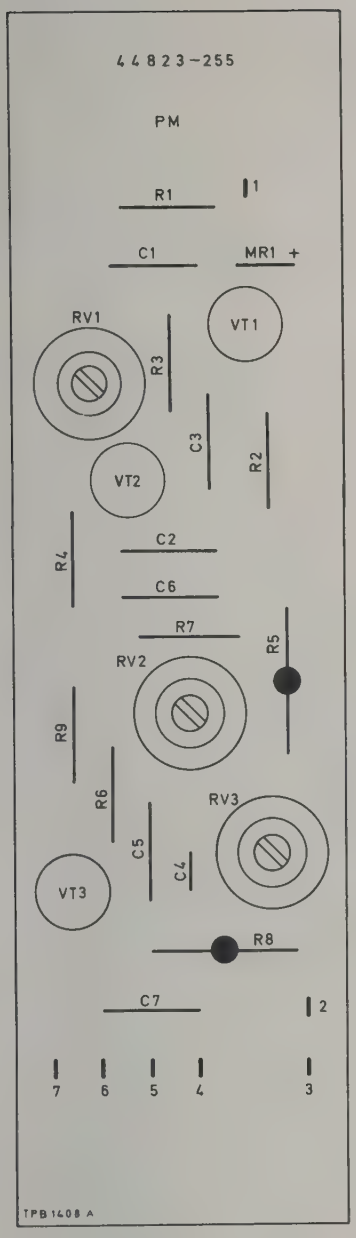


Fig. 5.5 Component location, board 12, fine level

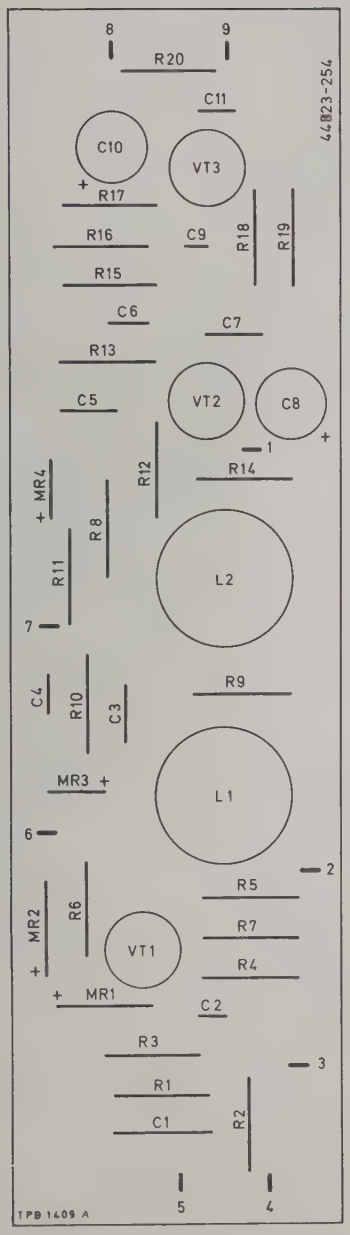


Fig. 5.6 Component location, board 13, external markers

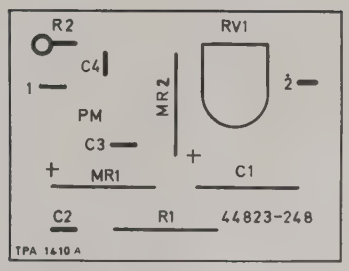


Fig. 5.7 Component location, board 14, internal a.l.c. detector

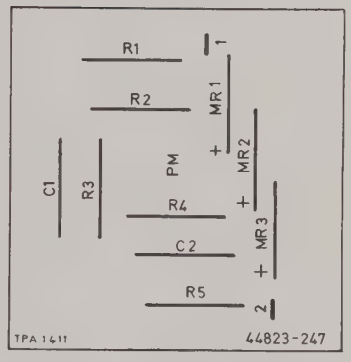


Fig. 5.8 Component location, board 15, a.l.c. modulator

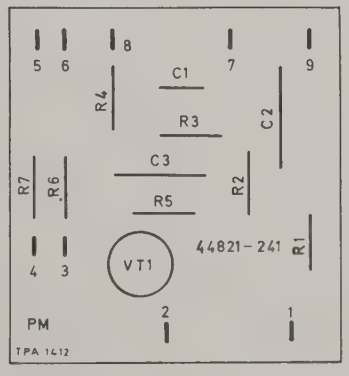


Fig. 5.9 Component location, board 16, swept oscillator amplifier

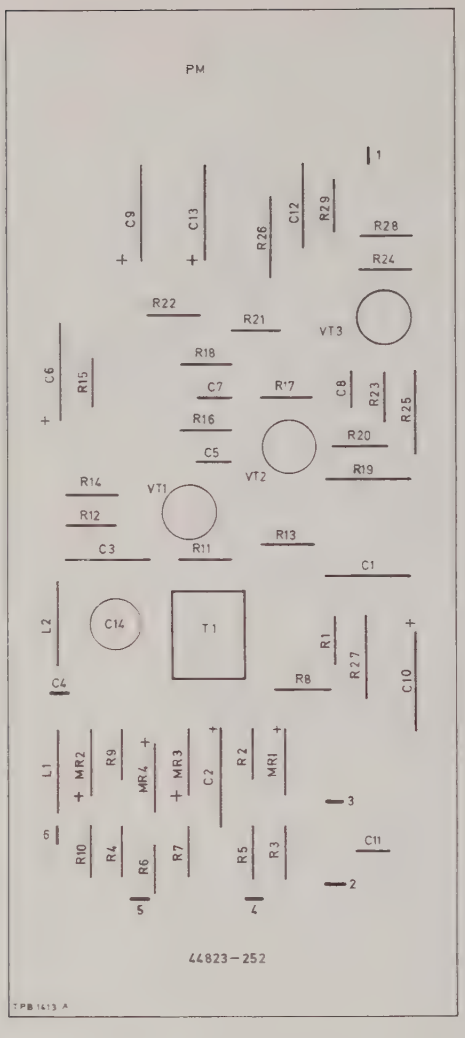


Fig. 5.10 *Component location, board 17, mixer and pre-amplifier*

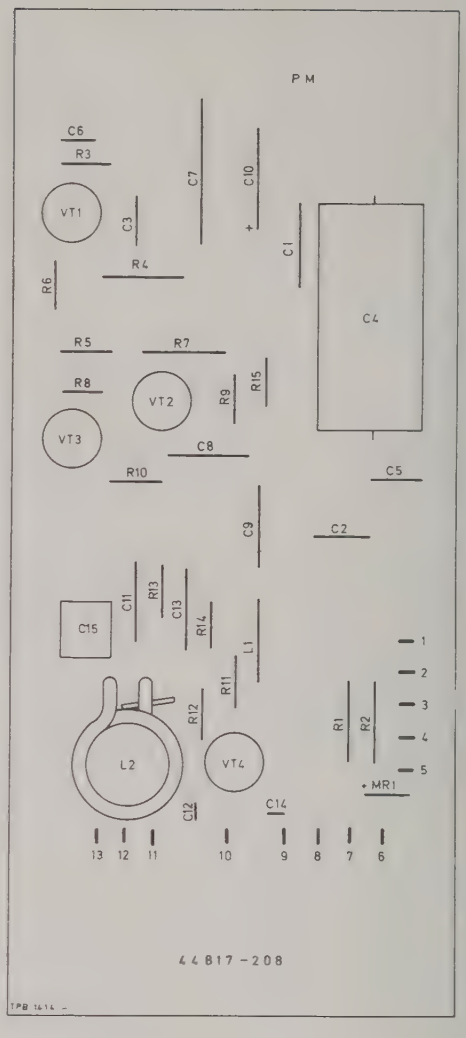


Fig. 5.11 *Component location, board 18, a.l.c. amplifier*

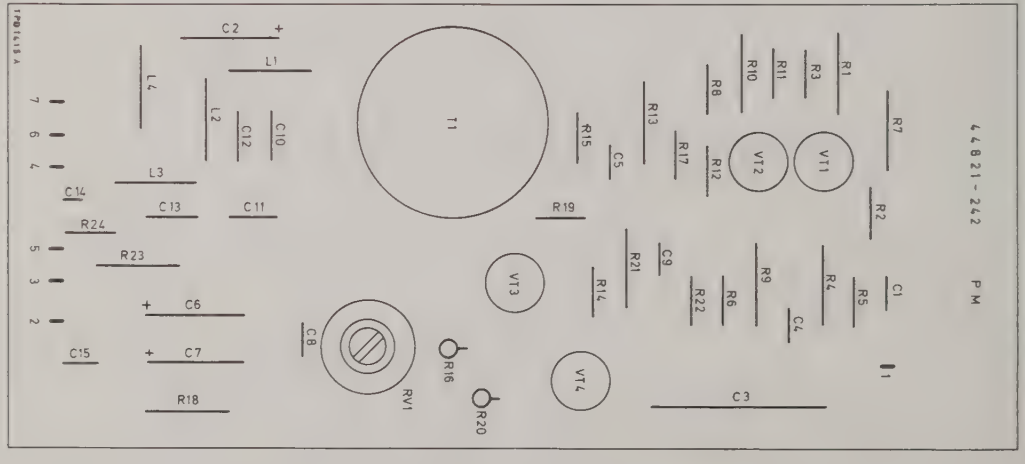


Fig. 5.12 *Component location, board 19, main amplifier and output filter*

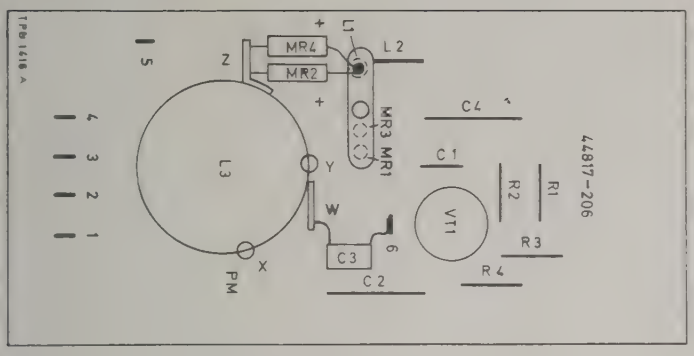


Fig. 5.13 Component location, board 20, swept oscillator

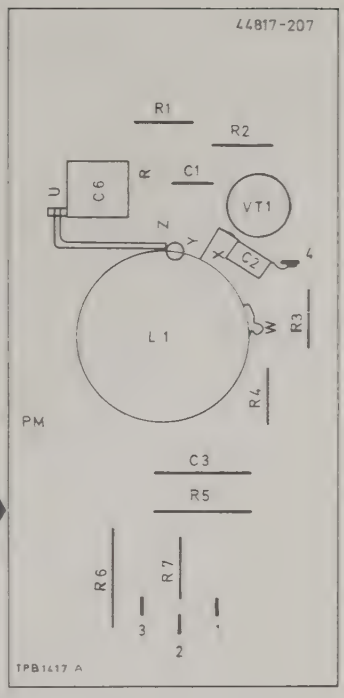


Fig. 5.14 Component location, board 21, fixed oscillator

Fig. 5.16 Component location, board 23, internal markers

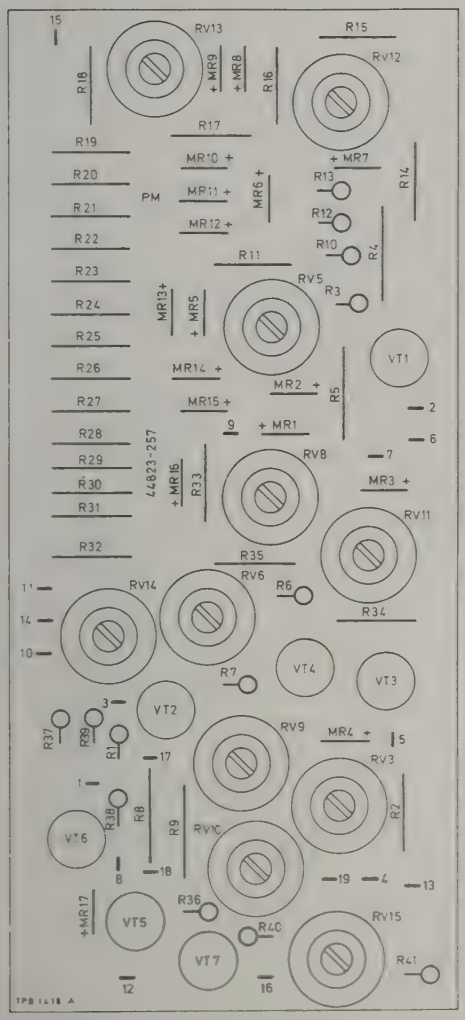
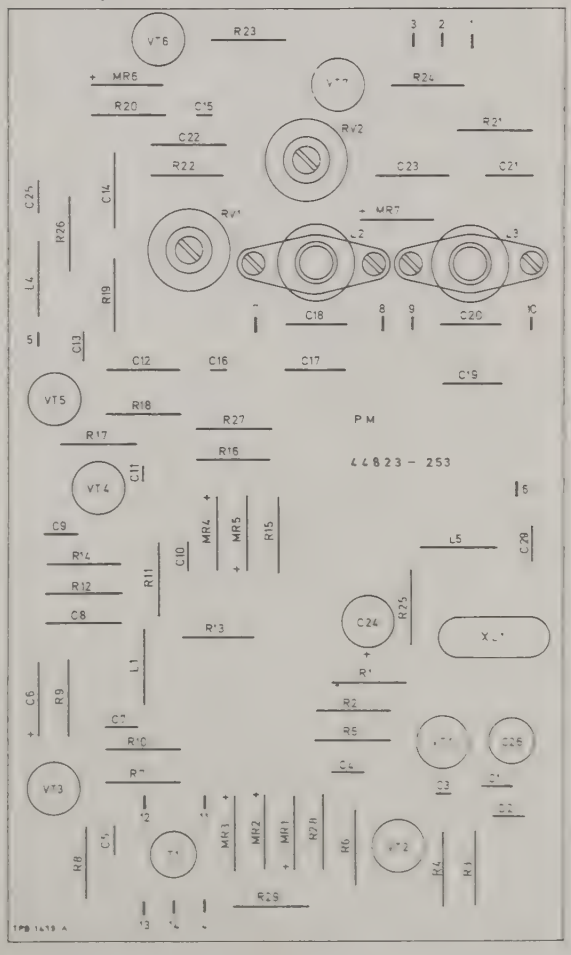


Fig. 5.15 Component location, board 22, distorter and drive unit



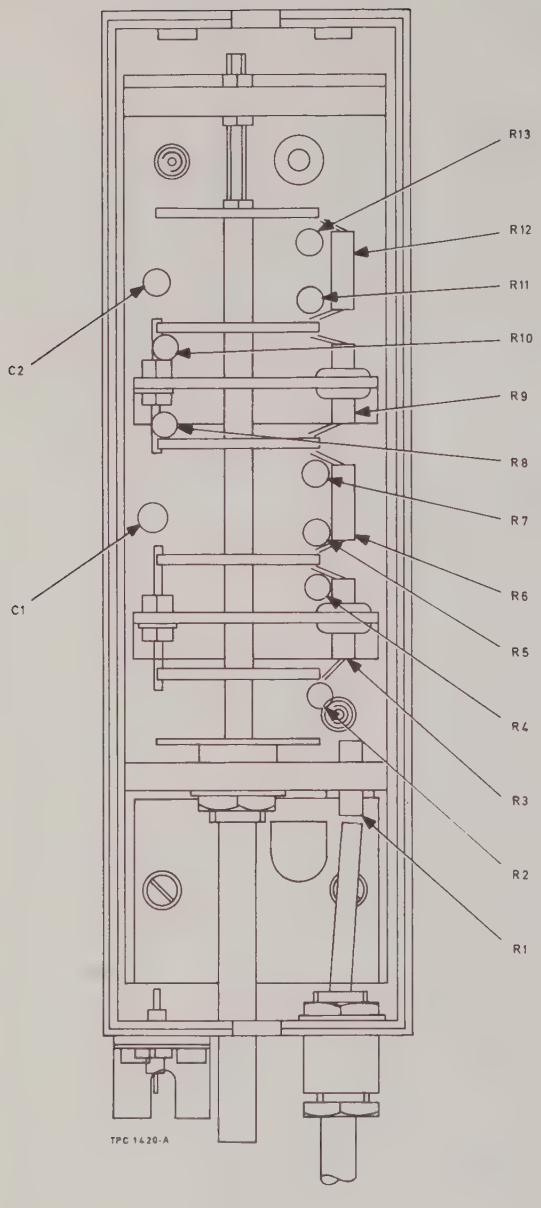


Fig. 5.17 Component location, board 24, fine attenuator

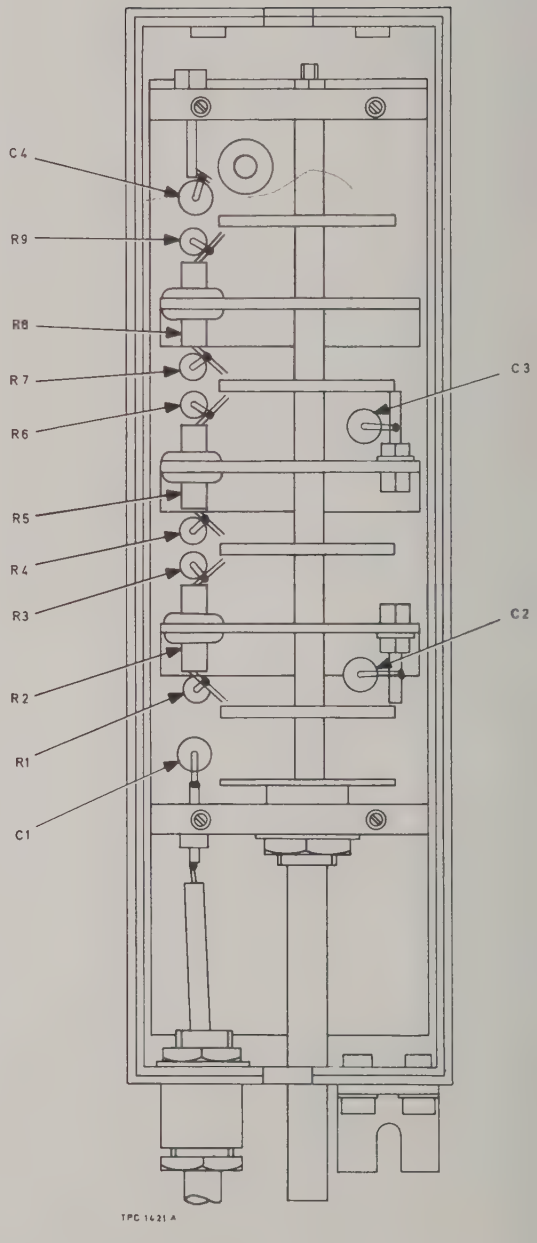


Fig. 5.18 Component location, board 25, coarse attenuator

5.7 ADJUSTMENT AND CALIBRATION

5.7.1 Test equipment required

This section provides a list of the test equipment that will be required to carry out the adjustment and calibration procedures detailed in this chapter. Do not attempt to calibrate the instrument using test equipment having an accuracy less than that of the items recommended. If repair, adjustment or calibration is necessary and adequate test equipment is not available, the instrument should be returned to the manufacturer, where a repair and calibration service is provided.

a) Sweep generator main unit, M.I. TF 2361.

b) Extension cable assembly, M.I. TM 9912.

c) Oscilloscope, such as M.I. TF 2201.

d) Oscilloscope single trace unit and time base unit, M.I. TM 6967 for use with c).

e) Oscilloscope graticule projector, M.I. TM 8098.

f) Oscilloscope graticule, see Fig. 5.19.

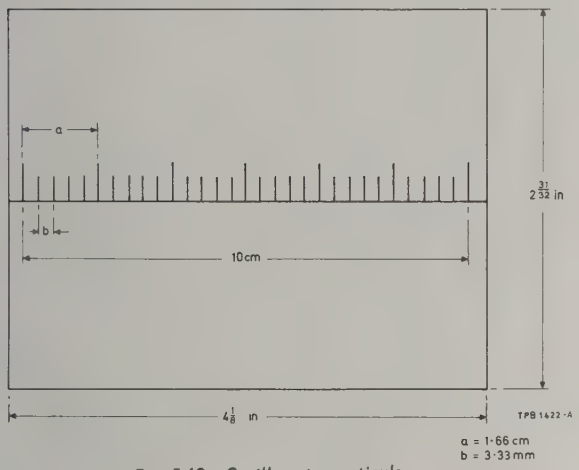


Fig. 5.19 Oscilloscope graticule

g) R.F. voltmeter, such as M.I. TF 2603.

h) Signal generator, 500 kHz to 30 MHz, such as M.I. TF 144H.

i) Video detector, M.I. TM 9703. *

j) Video a.l.c. detector, M.I. TM 9704.

k) Valve voltmeter, such as M.I. TF 2600.

l) Wavemeter, such as M.I. TF 643C.

m) Wavemeter coil 70 to 130 MHz.

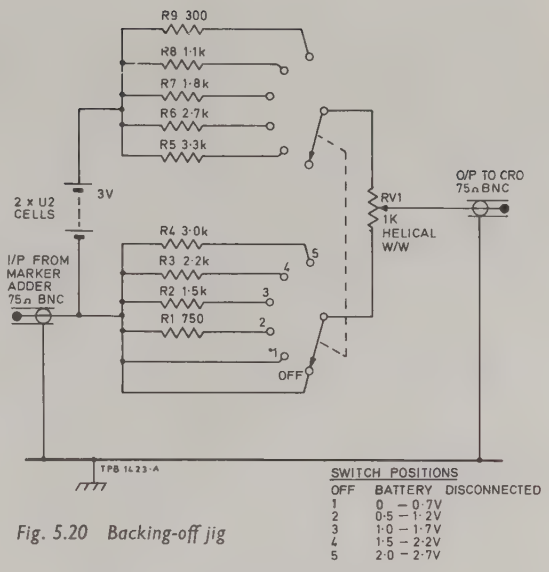


Fig. 5.20 Backing-off jig

n) AM/FM modulation meter, such as M.I. TF 2300.

o) Counter frequency meter, such as M.I. TF 1417 series.

p) Backing-off jig, see Fig. 5.20.

q) Attenuator pad 0 to 1 dB, see Fig. 5.21.

r) Adaptor 75 Ω BNC to probe, GE 80027.

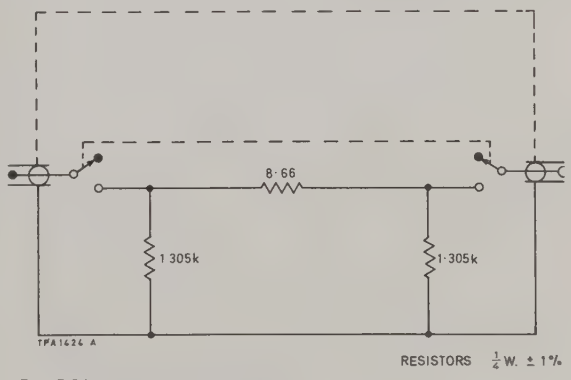


Fig. 5.21 Attenuator pad 0-1 dB

s) T connector 75 Ω BNC.

t) 75 Ω load, see Fig. 5.22.

* Accessories supplied with instrument

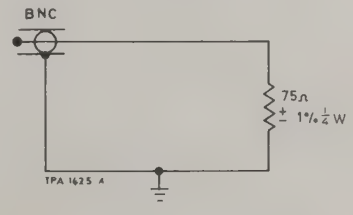


Fig. 5.22 75 Ω load

5.7.2 Initial conditions

For adjustment and calibration, remove the plug-in unit from the sweep generator TF 2361, and fit the extension cable TM 9912. Ensure that the main unit power supplies are OFF while this is being done. Take all necessary precautions to prevent dirt or foreign bodies entering the unit, and avoid accidental contact with exposed terminals.

Set the front panel controls to the following positions:

(A) Main unit

SUPPLY switch ON.

SWEEP MODE switch at NORMAL.

SWEEP FUNCTION switch at 10 - 100 Hz.

VARIABLE RATE control at mid-position.

RATIO switch at 10:1.

A.L.C. switch at INTERNAL.

MARKER switch ON.

PHASE SHIFT control fully counter-clockwise.

X-DRIVE switch at FORWARD.

X-DRIVE LEVEL control fully clockwise.

BLANKING switch ON.

EXTERNAL DRIVE SET LEVEL control fully counter-clockwise.

(B) Video plug-in

SWEEP WIDTH SELECTOR at WIDE.

SWEEP WIDTH (wide) control fully clockwise.

CENTRE FREQUENCY control at 15 MHz.

FINE CENTRE FREQUENCY control at 0 (mid-position).

OPTIMIZE BLANKING TRANSIENT control at mid-position.

MARKERS switch at INTERNAL + EXTERNAL.

MARKER HEIGHT control at mid-position.

EXTERNAL MARKER BANDWIDTH switch at WIDE.

A.L.C. BANDWIDTH switch at NORMAL.

SWEEP LINEARITY switch at LINEAR.

A.L.C. LEVEL control fully clockwise (INT).

FINE LEVEL control at 0 dB (mid-position).

FINE LEVEL SELECTOR at CONTINUOUS.

Both attenuator controls at 0 dB.

5.7.3 Fixed oscillator and sweep calibration

Test equipment: a, b, c, d, e, f, h, l and m

(1) Connect the oscilloscope horizontal input to the X-DRIVE OUTPUT socket, switch the oscilloscope time base to EXT, set the horizontal expansion control to the three-quarter clockwise position, and adjust the X-DRIVE LEVEL control so that the trace is the width of the graticule. Connect the detectorTM 9703 to the oscilloscope vertical input, and set the oscilloscope sensitivity to 1 V/cm, gain to maximum. Set the OPTIMIZE BLANKING TRANSIENT control fully clockwise.

(2) Remove the clip-on covers from the fixed oscillator and a.l.c. amplifier boards (boards 18 and 21). Place the wavemeter as close as possible to L2 on the a.l.c. amplifier board, and tune C15 on this board so that a peak response is displayed on the oscilloscope. Adjust the wavemeter frequency until a suck-out appears on the trace, and note the wavemeter frequency.

(3) If the wavemeter frequency is outside the limits 130 MHz ±1 MHz, adjust C6 on the fixed oscillator board to reduce the error, re-tune C15 on board 18, and re-check the frequency with the wavemeter.

(4) Repeat the adjustments in paragraph (3) until the fixed oscillator frequency is within the limits specified. Replace the clip-on covers.

(5) Fit the special graticule in the oscilloscope graticule projector, and fit the graticule projector to the oscilloscope. Remove the clip-on cover from the distorter and drive unit (board 22), and adjust the preset controls to the following positions: RV9, RV12, RV13 and RV15 to mid-position; RV3 and RV14 fully clockwise.

(6) Adjust RV15 so that the zero break marker is approximately 0.5 cm from the left-hand edge of the trace, then reduce the centre frequency control to zero and adjust RV8 until this marker is in the centre of the graticule. Put the SWEEP LINEARITY switch to the SEMI-LOG position and adjust RV11 until the zero marker is in the centre of the graticule. Repeat the two adjustments until no difference is observed when switching between linear and semi-log sweep. If either RV8 or RV11 have insufficient adjustment, readjust RV15 as required.

(7) Connect the signal generator to the EXTERNAL MARKER INPUT socket, and set it for 30 MHz 500 mV p-p output. Set the CENTRE FREQUENCY control to 30 MHz, switch to LINEAR sweep and adjust RV10 until the 30 MHz marker is in the centre of the graticule (this marker will be distinctive because it will be combined with the external marker). Switch to semi-log sweep and adjust RV6 in the same way, and repeat the two adjustments until no difference is observed when switching between linear and semi-log. If either RV6 or RV10 have insufficient adjustment, make a slight adjustment of RV9 as required.

(8) Repeat paragraphs (6) and (7) after the adjustment has been operating continuously for two hours. Disconnect the signal generator.

(9) Set the SWEEP LINEARITY switch to LINEAR and the SWEEP WIDTH control to maximum. Adjust RV3 on board 22 to give 33 MHz total sweep width, and adjust RV5 so that the sweep width extends from 1.5 MHz below zero to 1.5 MHz above 30 MHz.

(10) Use the oscilloscope horizontal shift and horizontal expansion controls to line up the 0 and 30 MHz markers with the outer lines on the special graticule, and adjust RV14 so that the 15 MHz marker appears on the centre line of the graticule. Check the closeness of the 5, 10, 20 and 25 MHz markers to the corresponding graticule lines, and if the discrepancies are greater than 0.5 MHz adjust RV12 and RV13, followed by readjustment of RV14. If the discrepancies cannot be reduced to less than 0.5 MHz, try resetting RV15 or RV9 and repeat paragraphs (6), (7), (8), (9) and (10).

(11) The following check should only be necessary following repair or replacement of components. Reduce the sweep width to 2 MHz and observe the 15 MHz marker with the centre frequency set to 15 MHz. It should be within ±1 cm of the graticule centre line. If the error is greater than this, the value of the selected resistor R8 on board 22 must be changed; suggested values are 500 kΩ for an error of 1 cm (200 kHz), 220 kΩ for 2 cm (400 kHz), or 110 kΩ for 3 cm (600 kHz). If the value is changed, paragraphs (6) to (10) must be repeated.

(12) Adjust the CENTRE FREQUENCY control so that the 5 MHz marker is in the centre of the graticule, and adjust the SWEEP WIDTH control so that the 4 and 6 MHz markers are on the outer graticule lines. Adjust the OPTIMIZE BLANKING TRANSIENT control as necessary to make the right-hand marker visible. Set the CENTRE FREQUENCY to exactly 5 MHz on the scale and note the amount the 5 MHz marker has moved; the movement should be less than 2 cm (0.4 MHz).

(13) Repeat paragraph (12) for every 5 MHz marker up to and including that at 30 MHz.

(14) Set the SWEEP LINEARITY switch to SEMI-LOG, the SWEEP WIDTH control to 2MHz and adjust the CENTRE FREQUENCY control so that the zero break marker is in the centre of the graticule. Check that the centre frequency indicated on the scale is within ±1 MHz of zero on the linear scale.

(15) Set the SWEEP WIDTH and CENTRE FREQUENCY controls so that the 28 and 32 MHz markers are on the outer lines of the graticule, then set the sweep width pointer to 30 MHz on the scale. Check that the 30 MHz marker is still visible on the display. Refit the cover on board 22. Remove the graticule projector from the oscilloscope.

5.7.4 Internal markers

Test equipment: a, b, c, d and h

(1) Revert to the initial conditions given in Sect. 5.7.2, and connect the oscilloscope as in paragraph 5.7.3 (1). Connect the signal generator to the external marker input socket, and set it to 30 MHz, XTAL CHECK position, zero beat from crystal calibrator, 500 mV p-p output.

(2) Set the CENTRE FREQUENCY control to 30 MHz and adjust the SWEEP WIDTH control so that only the 30 MHz marker is displayed. Remove the cover from board 23 (internal markers) and adjust C6 so that the marker displayed (which is a type of lissajous figure) has minimum roll-over and a minimum number of vertical bands or stripes. Disconnect the signal generator.

(3) Set the SWEEP WIDTH SELECTOR to NARROW, the NARROW SWEEP WIDTH control fully clockwise (1 MHz) and the CENTRE FREQUENCY control to 1 MHz. Adjust RV2 on board 23 so that the smallest width 1 MHz marker is 5 mm ±1 mm wide at half the marker height. The 2 MHz markers will then be approximately 1 cm wide.

(4) Adjust the CENTRE FREQUENCY control so that the 5 MHz marker is displayed, and adjust RV1 so that this marker is between 1.1 and 1.2 cm wide at half the marker height.

(5) Set the SWEEP WIDTH SELECTOR to WIDE, the SWEEP WIDTH control fully clockwise and the CENTRE FREQUENCY control to 15 MHz. Set the RATIO switch to 1:1 and the VARIABLE RATE control fully clockwise. Check that all 1 MHz and 5 MHz markers are present.

(6) Connect the signal generator to the EXTERNAL MARKER INPUT socket and set it to 1 MHz, XTAL CHECK position, 500 mV p-p. Set the EXTERNAL MARKER BANDWIDTH switch to NARROW, the SWEEP WIDTH switch to NARROW, the NARROW SWEEP WIDTH control to 0.25 MHz, the VARIABLE RATE control fully counter-clockwise, and adjust the CENTRE FREQUENCY and FINE CENTRE FREQUENCY controls so that the 1 MHz internal marker is superimposed on the 1 MHz external marker, in the centre of the graticule.

(7) Adjust the NARROW SWEEP WIDTH control so that the internal marker is 2 cm wide, and adjust the core of L3 on board 23 so that this internal marker is centrally located with respect to the external marker, i.e. 1 cm ±2 mm on either side of the centre of the external marker. This gives an internal marker accuracy of ±10 kHz.

(8) Set the signal generator frequency to 2 MHz and adjust the CENTRE FREQUENCY and FINE CENTRE FREQUENCY controls so that the 2 MHz external marker is in the centre of the graticule, superimposed on the 2 MHz internal marker.

(9) Adjust the NARROW SWEEP WIDTH control so that the internal marker is 4 cm wide, and adjust the core of L2 so that this internal marker is centrally located with respect to the external marker, i.e. 2 cm ±2 mm on either side of the centre of the external marker. This gives an accuracy of ±10 kHz.

(10) Repeat paragraphs (8) and (9) as necessary, because the adjustments on L2 and L3 interact. Disconnect the signal generator.

(11) Set the VARIABLE RATE control fully clockwise, the MARKER HEIGHT control fully clockwise, the SWEEP WIDTH SELECTOR to WIDE, the WIDE SWEEP WIDTH control to 5 MHz and the CENTRE FREQUENCY control to 5 MHz.

(12) Adjust RV1 so that the amplitude of the 5 MHz marker is 5.3 V ±0.3 V, and adjust RV2 so the amplitude of the 1 MHz markers is 3.5 V ±0.3 V. Refit the cover on board 23.

5.7.5 External markers

Test equipment: a, b, c, d, g, h, r, s and t

(1) Check that the initial conditions are as quoted in Sect. 5.7.2, except for MARKER HEIGHT control fully clockwise and MARKERS switch at EXTERNAL. Connect the oscilloscope as in paragraph 5.7.3 (1) and set it to CAL. Connect the 75 Ω load across the signal generator output, and connect the signal generator output to the EXTERNAL MARKER INPUT socket via the T connector. Set the signal generator to 30 MHz, 175 mV r.m.s. output as measured on the r.f. voltmeter connected into the T junction.

(2) Check that the amplitude of the displayed external marker is greater than 2.5 V p-p. Repeat for signal generator frequencies of 20 MHz, 10 MHz, 5 MHz, 1 MHz and 300 kHz, adjusting the sweep width and centre frequency controls as necessary.

(3) Set the EXTERNAL MARKER BANDWIDTH switch to NARROW, the A.L.C. BANDWIDTH switch to LF, and the SWEEP FUNCTION switch to 1 - 10 MHz. Repeat paragraph (2) for signal generator frequencies of 100 kHz, 50 kHz and 25 kHz, adjusting the VARIABLE RATE control as necessary.

(4) Set the EXTERNAL MARKER BANDWIDTH switch to WIDE, the A.L.C. BANDWIDTH switch to NORMAL and the MARKERS switch to INTERNAL + EXTERNAL. Sweep the signal generator frequency slowly over the range 25 kHz to 30 MHz and check that the markers displayed are internal plus external at each 1 MHz interval.

(5) Set the signal generator frequency to 25 kHz, the oscilloscope sensitivity to 0.5 V/cm, the MARKERS switch to EXTERNAL, and adjust the signal generator output level until the amplitude of

the displayed marker is 5 cm p-p. Check that the marker breakthrough is less than 0.8 cm (see Fig. 5.23). Disconnect the signal generator.

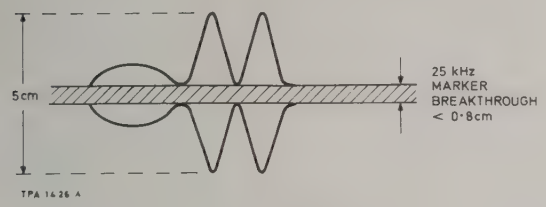


Fig. 5.23 Marker breakthrough

5.7.6 Detected system flatness, harmonic distortion and output level

Test equipment: a, b, c, d, i, k, p, q and t

(1) Set the front panel controls as in Sect. 5.7.2, except for the following:

MARKER switch OFF.

FINE LEVEL control at +0.1 dB.

FINE LEVEL SELECTOR at ALTERNATE.

(2) Connect the oscilloscope as in paragraph 5.7.3 (1). Connect the video detector (switched to NORMAL) to the VIDEO OUTPUT socket on the video sweep unit and terminate it with 75 Ω.

(3) Increase the oscilloscope sensitivity as far as the vertical shift allows without losing the top of the display, and position the two traces above and below the horizontal centre line of the graticule without overlap (see Fig. 4.2 in chapter 4).

(4) If the trace cuts the centre line the system flatness is outside its specified limits; improvement can be effected first by adjusting RV1 on board 14 (a.l.c. modulator), second by adjusting C15 on board 18 (a.l.c. amplifier) or T1 core on board 17 (mixer and pre-amplifier). However, if these last two are adjusted, it is likely that the harmonic distortion characteristics will be affected.

(5) Checks on harmonic distortion cannot be made without a spectrum analyser, or a special frequency selective harmonic free amplifier tuned to 50 kHz, 100 kHz, 1, 5, 10, 15, 20, 25, 30, 39 and 45 MHz. The connection diagram is shown in Fig. 5.24. Only general guidance is given here on harmonic distortion checks; detailed instructions can be obtained from the manufacturer, if required.

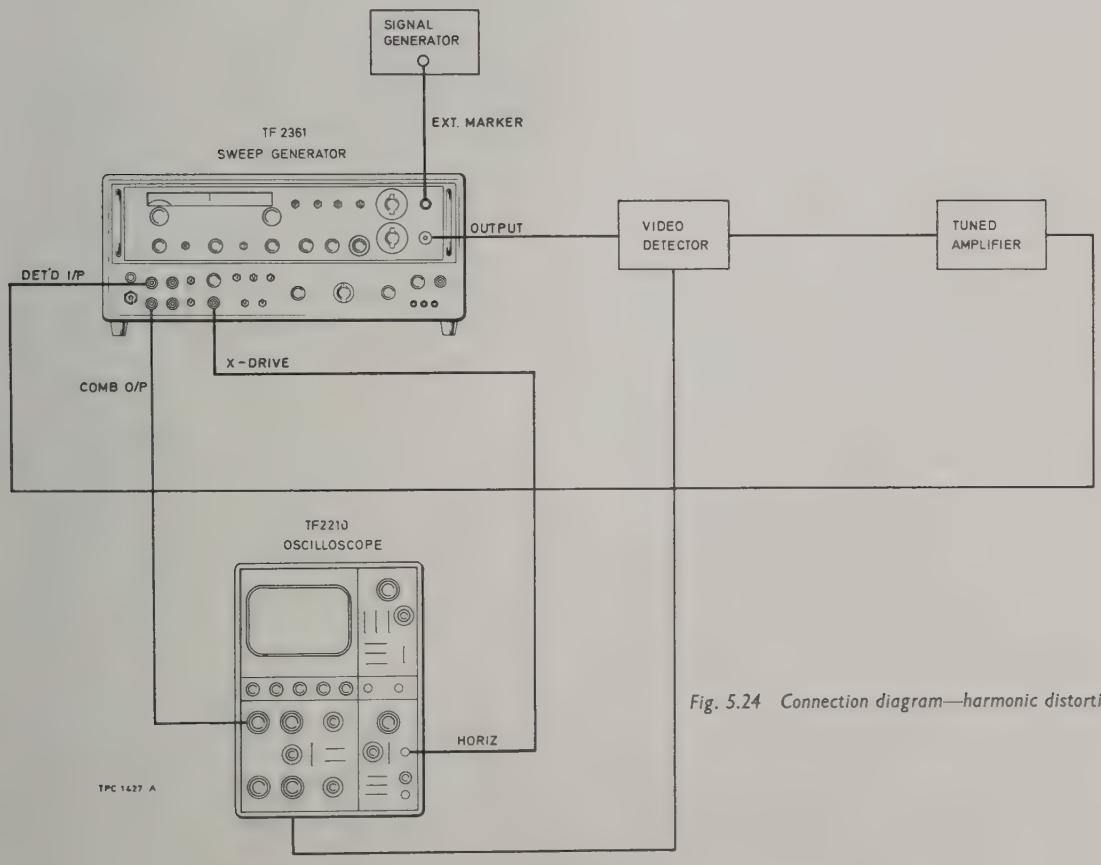


Fig. 5.24 Connection diagram—harmonic distortion check

(6) The method is to apply a c.w. signal as an external marker and display it so that the harmonics are visible as in Fig. 5.25. Note the level of the largest harmonic, then reduce the fundamental to this level by using the output attenuators. The amount of attenuation inserted will give the distortion level in dB; the requirement is for a distortion level at least 40 dB down at all frequencies.

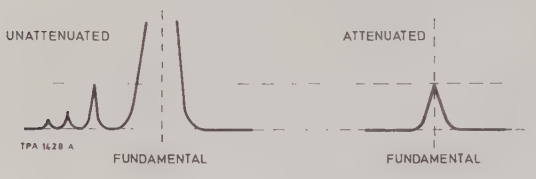


Fig. 5.25 Display for harmonic distortion check

(7) Note that when checking the 50 kHz and 100 kHz points, the SWEEP WIDTH SELECTOR must be set to NARROW and the a.l.c. and detector bandwidths set to LF.

(8) To reduce the harmonic distortion at any fundamental frequency, adjust C15 on board 18 or T1 core on board 17, then check the remaining fundamental frequencies to see that the harmonics have not been made worse. At the same time a constant check must be kept on detected system flatness, since adjusting C15 and T1 will affect this characteristic. At the 30 MHz fundamental, adjust RV1 on board 19 for minimum second harmonic; it is, however, normal for RV1 to be set fully clockwise.

(9) At any fundamental frequency selected from the tuned amplifier or spectrum analyser, examine the display to the right of the fundamental to see the spurious signals. To minimize these, adjust C14 on board 17 so that they are at least 40 dB down.

(10) To check the output level, revert to the initial conditions in Sect. 5.7.2, connect the video detector terminated with 75 Ω to the video plug-in output, and connect the output of the detector to the oscilloscope vertical input. Turn the MARKER switch OFF, and the FINE LEVEL SELECTOR to ALTERNATE. Adjust RV2 on board 12 until the two traces displayed are coincident.

(11) Set the SWEEP FUNCTION switch to CW, the FINE LEVEL SELECTOR to CONTINUOUS and the centre frequency to 1 MHz. Connect the output of the video sweep unit to the valve voltmeter with a 75 Ω load, and adjust RV3 on board 12 until the valve voltmeter indicates 1 V r.m.s. ±2%. Check the output impedance by removing the 75 Ω load and observing that the output voltage rises to 2 V r.m.s. ±2%. Disconnect the detector.

(12) Connect the video a.l.c. detector (switched to 75 Ω) to the video sweep unit output, and the output of the a.l.c. detector loaded with 75 Ω to the valve voltmeter and to the external a.l.c. input socket on the main unit. Check that the valve voltmeter indicates 0.66 V ±10%, and make a note of the exact indication. Set the A.L.C. switch to EXTERNAL and check that the level can be restored to its original value by adjustment of the A.L.C. LEVEL control.

(13) Revert to the initial conditions of Sect. 5.7.2 and connect the equipment as shown in Fig. 5.26. Set the oscilloscope sensitivity to 0.5 V/cm, switch in 1 dB on the 0 - 1 dB pad, and adjust the oscilloscope gain and the level from the backing-off jig so that a change of 1 dB covers 5 cm on the graticule.

(14) Set the FINE LEVEL SELECTOR to ALTERNATE and switch the 0 - 1 dB pad to 0 dB. Note the position of the trace, then set the FINE LEVEL control to -1 dB and note the trace separation.

(15) If the trace separation is greater than 5 cm ±2 mm, return the FINE LEVEL control to 0 dB and note the trace level. Adjust RV3 on board 12 until the upper trace is returned to the original level noted in paragraph (14). Set the FINE LEVEL control to -1 dB and recheck the trace separation.

(16) If the trace separation is less than 5 cm -2 mm, return the FINE LEVEL control to 0 dB and note the trace level. Adjust RV1 on board 12 in a more clockwise direction, then readjust RV3 until the upper trace is returned to its original level noted in paragraph (14). Set the FINE LEVEL control to -1 dB and recheck the trace separation.

(17) Set the 0 - 1 dB pad to 1 dB and the FINE LEVEL control to +1 dB, then check the 5 cm trace separation. If the accuracy of the ±1 dB points is such that one is accurate while the other is in error, then RV1 and RV3 must be adjusted to give the least possible error equalized at each end of the range.

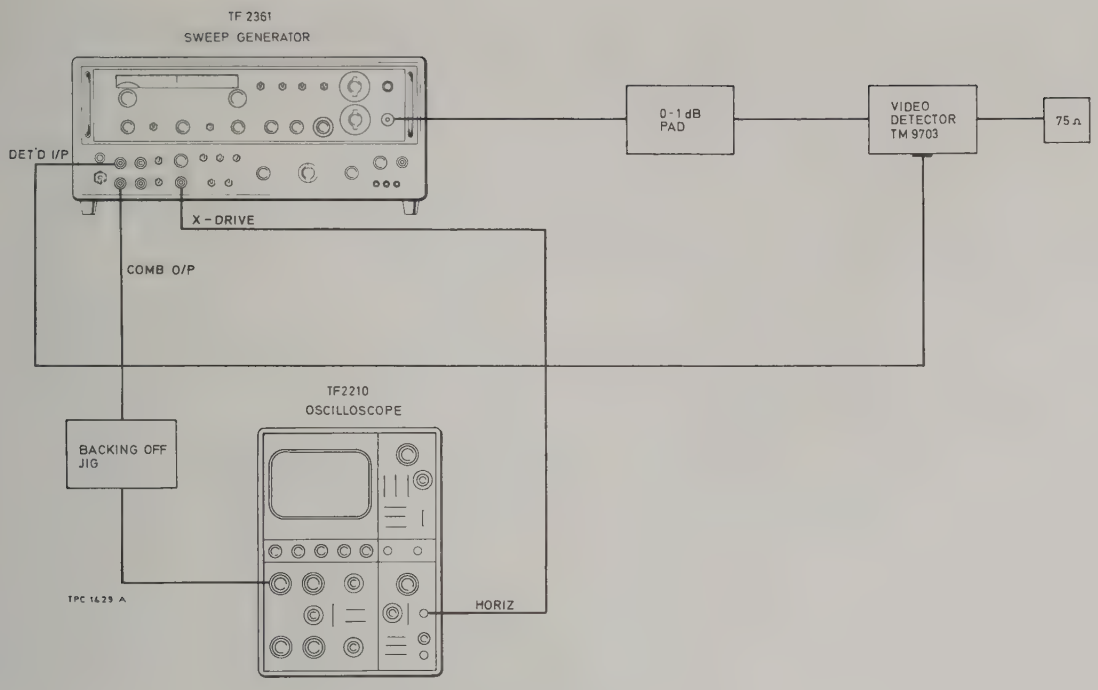


Fig. 5.26 Connection diagram—fine level check

5.7.7 Attenuator accuracy

Test equipment: a, b, c, d, i, k, p and t

(1) For this check you need a standard attenuator having 0 to 50 dB of attenuation in 10 dB steps and 0 to 11 dB in 1 dB steps, calibrated to an accuracy of ±0.6% ±0.04 dB. The test connections are the same as in Fig. 5.26, with the standard attenuator connected in place of the 0 to 1 dB pad. Initial conditions are as in Sect. 5.7.2, except for the following:

SWEEP FUNCTION switch at MAINS LOCK.

CENTRE FREQUENCY control at 1 MHz.

SWEEP WIDTH switch at NARROW.

SWEEP WIDTH (narrow) control fully counter clockwise.

FINE LEVEL SELECTOR at ALTERNATE.

FINE LEVEL control at +0.2 dB.

(2) Set the standard attenuator to 11 dB, the oscilloscope sensitivity to 0.005 V/cm and switch the video detector to NORMAL. Adjust the oscilloscope gain and the backing-off jig level so that 0.2 dB covers 3 cm on the graticule, i.e. 1 mm = 0.0066 dB.

(3) Turn BLANKING switch to OFF, FINE LEVEL SELECTOR to CONTINUOUS and the video detector to LF. Note the trace position as a reference.

(4) Switch the fine attenuator to 1 dB and the standard attenuator to 10 dB, then check that the trace has not moved by more than ±6.9 mm from the reference trace. Repeat for the 2 dB to 11 dB steps of the fine attenuator and for the first step of the coarse attenuator.

(5) To cover the range of the coarse attenuator, connect the output from the standard attenuator to the input of the valve voltmeter (terminated with 75 Ω), and connect the amplifier output of the valve voltmeter to the video detector input. Turn the BLANKING switch to ON, the FINE LEVEL SELECTOR to ALTERNATE and the video detector to NORMAL. Set the valve voltmeter range switch so that the meter indicates as closely as possible to full-scale deflection. Adjust the oscilloscope gain and the backing-off jig level so that 0.2 dB covers 8 mm on the graticule, i.e. 1 mm = 0.025 dB.

(6) Turn the BLANKING switch to OFF, the FINE LEVEL SELECTOR to CONTINUOUS and the video detector to LF. Set both coarse and fine attenuators to 0 dB and the standard attenuator to 50 dB. Reset the valve voltmeter range for near full-scale deflection and adjust the level of the backing-off jig to give a level on the oscilloscope that can be used as a reference.

(7) Switch the coarse attenuator to 10 dB and the standard attenuator to 40 dB, and check that the trace has not moved by more than ±6.5 mm from the reference trace. Repeat for the 20 to 50 dB steps of the coarse attenuator.

5.7.8 Attenuated output flatness

Test equipment: a, b, g, r, s and t

(1) Revert to the initial conditions of Sect. 5.8.1, with the SWEEP FUNCTION switch at CW. Set the coarse attenuator to 10 dB, and connect the r.f. voltmeter via the T connector loaded with 75 Ω to the VIDEO OUTPUT socket. Set the voltmeter to the 300 mV range and adjust the FINE LEVEL control for 0 dB indication on the r.f. voltmeter.

(2) Adjust the CENTRE FREQUENCY control so that the sweep output varies from just below zero to 30 MHz, and note the voltmeter indication at 1 MHz intervals. The attenuated output flatness should be within ±0.06 dB ±0.5% of attenuator setting.

(3) Repeat the procedure for the 20, 30, 40, 50 and 60 dB settings. On the highest settings the 1 mV range of the voltmeter may be used, and here the dB scale does not apply; in this case use the full-scale deflection of 1 mV as the reference, and the flatness should lie within the range 0.92 mV to 1 mV.

5.7.9 Marker spacing

Test equipment: a, b, c and d

(1) Set the front panel controls as in Sect. 5.7.2, and connect the oscilloscope as in para. 5.7.3 (1). Set the oscilloscope to d.c. coupling, sensitivity 2 V/cm, time base 2 ms/cm, and adjust so that the 0 and 30 MHz markers are 10 cm apart on the graticule. Set the oscilloscope X-expansion to x5, with the time scale at zero on the x1 range.

(2) For each marker in turn from 30 MHz to zero use the horizontal shift control to position that marker in the centre of the graticule, then adjust the time scale control on the oscilloscope until the adjacent marker at a lower frequency is in the centre of the graticule. Record the time indicated on the time scale. Return the time scale control to zero and proceed to the next marker, using the horizontal shift, and repeat the measurement.

(3) When all 30 time intervals have been recorded, check that the ratio of the maximum interval to the minimum interval is not greater than 1.4 to 1.

5.7.10 Narrow sweep width and fine centre frequency

Test equipment: a, b, c and d

(1) Set the front panel controls as in Sect. 5.7.2, except the SWEEP WIDTH switch at NARROW and the SWEEP WIDTH (narrow) control fully clockwise. Connect the oscilloscope as in paragraph 5.7.3 (1).

(2) By adjusting the CENTRE FREQUENCY control, check that the sweep width at any point in the frequency range is between 0.9 MHz and 2 MHz.

(3) Set the FINE CENTRE FREQUENCY control to +150 kHz, and adjust the CENTRE FREQUENCY and NARROW SWEEP WIDTH controls until the 16 MHz and 17 MHz markers are displayed 10 cm apart. Adjust the FINE CENTRE FREQUENCY control to -150 kHz and check that the 16 MHz marker moves 2 cm ±1 cm to the right.

5.7.11 Residual frequency and amplitude modulation

Test equipment: a, b, c, d, g, n, s and t

(1) Set the front panel controls as in Sect. 5.7.2, except for the SWEEP FUNCTION switch at CW. Set up the modulation meter as follows:

Oscillator range:	external
De-emphasis:	50 μs
Function switch:	set cal
Deviation range:	5 kHz
Maximum modulation frequency:	15 kHz

(2) Connect the output of the modulation meter to the oscilloscope vertical input, a.c. coupled, with the oscilloscope time base internally triggered at 5 ms/cm. Adjust the vertical gain to give a trace height of 2 cm p-p, then increase the vertical gain ten times.

(3) Connect the VIDEO OUTPUT to the r.f. input socket on the modulation meter, and set its function switch to TUNE. Adjust the sweep centre frequency

for a maximum indication on the meter, and adjust the level control until the meter indicates full-scale deflection. Set the function switch to SET FREQUENCY and adjust the CENTRE FREQUENCY control until the meter indicates 'set'.

(4) Set the function switch to DEV + and observe the oscilloscope trace. The height should be less than 1 cm p-p, corresponding to a peak deviation of 250 Hz.

(5) Set the function switch to TUNE, the oscillator range switch to 3-4 and the oscillator frequency to 31.5 MHz. Set the centre frequency to 30 MHz and adjust for a peak on the meter, then set the level and frequency as in paragraphs (3) and (4). The trace height should be less than 2.8 cm p-p, corresponding to a peak deviation of 700 Hz. Disconnect the modulation meter.

(6) To check the residual amplitude modulation, set the SWEEP FUNCTION switch to 10 - 100 Hz, the SWEEP MODE switch to ONE SHOT and the CENTRE FREQUENCY control to 5 MHz. Connect the r.f. voltmeter via the T connector loaded with 75 Ω to the VIDEO OUTPUT socket, and adjust the voltmeter sensitivity until a reading near to full-scale deflection is obtained. Note this reading as a reference.

(7) Set the SWEEP FUNCTION switch to CW, the SWEEP MODE switch to NORMAL, and the coarse output attenuator to 40 dB. Adjust the fine output attenuator until the voltmeter reading is the same as the reference level. Check that the attenuation is at least 42 dB.

5.7.12 Optimize blanking transient

Test equipment: a, b, c, d, i and t

(1) Set the front panel controls as in Sect. 5.7.2, except for the RATIO switch at 1:1. Connect the detector to the VIDEO OUTPUT socket, and the output of the detector loaded with 75 Ω to the oscilloscope vertical input. Connect the oscilloscope horizontal input to the X-drive output socket.

(2) Observe the display on the right of the graticule, which may take one of the two forms shown in Fig. 5.27, and check that adjustment of the OPTIMIZE BLANKING TRANSIENT control will achieve a flat response over the full sweep range. This should be possible under two extreme conditions: with the A.L.C. LEVEL control at mid-position and the FINE LEVEL control at -1 dB, or with the A.L.C. LEVEL control fully clockwise and the FINE LEVEL control at +1 dB.

Fig. 5.27 Optimize blanking transient characteristics

5.8 FAULT FINDING

Fault finding techniques should follow standard electronic practice, and little guidance is possible apart from giving a voltage analysis table. Faults can generally be localized by logical deduction; for example if there is a loss of linearity, check the sweep monitor output and if faulty suspect the main unit TF 2361 or the distorter and drive circuit; if they are not faulty, monitor pin 4 on board 20 and if the fault appears here suspect the varactor diodes. Check these by disconnecting them one at a time until the fault disappears. If the loss of linearity is only at the low frequency end, check VT5 on board 22 for leakage.

5.8.1 Voltage analysis

Voltages are shown on the circuit diagrams in Chap. 7. They were measured on a typical TM 9692 using an oscilloscope with a 10:1 probe, giving an input resistance of 10 MΩ. All measurements are with respect to ground (chassis) potential.

The front panel controls were set as in Sect. 5.7.2, except for SWEEP FUNCTION switch at CW, BLANKING switch OFF, A.L.C. switch at LF, OPTIMIZE BLANKING TRANSIENT control fully clockwise, and the sweep output loaded with 75 Ω.

5.9 REPLACEMENT OF DRIVE CORDS

5.9.1 Preparation

(1) Remove the front panel knobs from the SWEEP WIDTH and CENTRE FREQUENCY controls (4 BA hexagon socket head grub screws).

(2) Remove the three 6 BA screws securing the drive and potentiometer assembly to the front panel, slacken the screws securing the front panel to the chassis framework, and lift out the scale and drive assembly clear of the chassis. Take care not to strain the potentiometer leads.

(3) Remove broken ends of nylon cord.

(4) Referring to Fig. 5.28 set potentiometer A fully clockwise and potentiometer B to its mid-position (established by checking resistance with a multimeter). Ensure that the three interlocking pins at G are in contact, as shown.

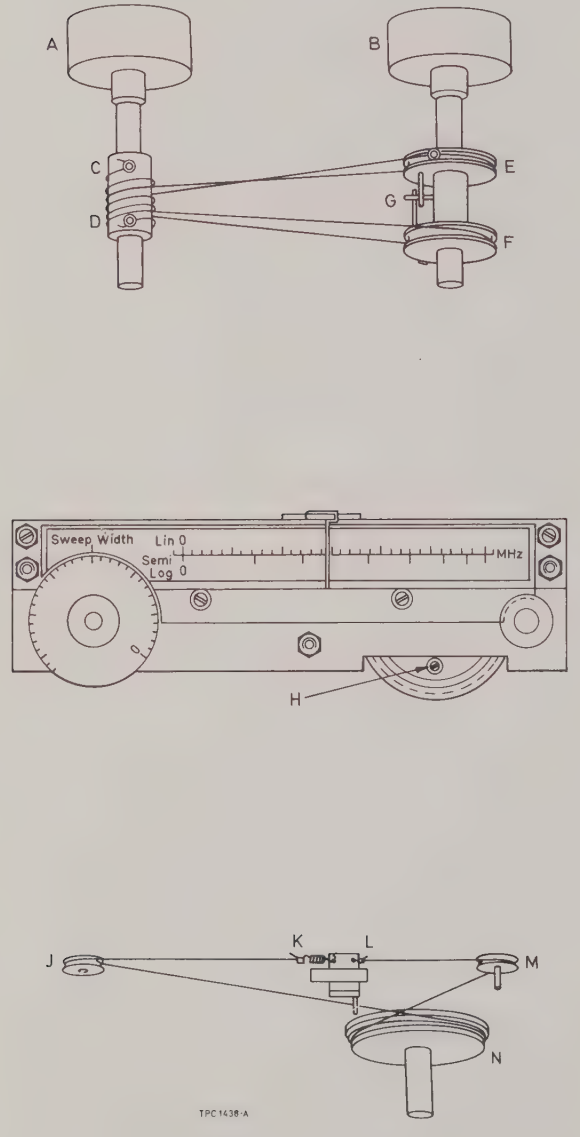


Fig. 5.28 Drive cord arrangement

5.9.2 Interlock cord

(1) Fix one end of the nylon cord under the 8 BA screw C, and make $1\frac{1}{2}$ turns on the drum C-D. Keep the cord tight at all times while it is being fitted. From the bottom of drum C-D take the cord to the top of drum E and pass it half a turn round to the bottom of the drum. From the bottom of drum E go to the top of drum C-D and pass the cord $2\frac{1}{2}$ times round drum C-D, finishing at the bottom. From the bottom of drum C-D go to the bottom of drum F, take $\frac{1}{2}$ turn round drum F to the top, and pass the cord back to the top of drum C-D, make one complete turn on drum C-D and secure it under the 8 BA screw D.

(2) Ensure that drum pins are either side and in contact with central pin as shown at point G. Then tighten down 8 BA screws on drums E and F to trap wire. Reset drive assembly as in paragraph 5.9.5.

5.9.3 Scale drive cord

(1) The length of nylon drive cord to be used as a replacement must be prestretched with a 4 lb weight for 24 hours before use.

(2) Slacken the two grub screws securing gear wheel N, and move the gear wheel round until the screw H is accessible through the cut-out section of the scale plate. Tighten the grub screws securing gear wheel N. (Potentiometers to be set as in 5.9.1 (4).)

(3) Pass the centre of the nylon cord through the hole in the drum opposite screw H, and secure this loop under screw H. Then take one end of the cord and make $1\frac{1}{2}$ turns round drum N in a clockwise direction as viewed from the front.

(4) From the top of the drum N take the cord round pulley M (from bottom to top) and secure it to the pointer carriage by passing it through the hole L in the carriage and fixing it with a ferrule. The carriage must be positioned so that the pointer is at the centre of the scale, i.e. at 15 MHz.

(5) Take the other end of the nylon cord and make $1\frac{1}{2}$ turns round drum N in a counter-clockwise direction as viewed from the front, then from the top of drum N go round pulley J (from bottom to top) and secure the cord to the spring K by fastening it with a ferrule, so that the spring is extended by approximately 1/8 inch (3.3 mm). Reset drive assembly as in paragraph 5.9.5.

5.9.4 Replacement of potentiometers

(1) To remove a potentiometer unscrew the 3/8 inch nut and slacken the two 8 BA hexagon socket head grub screws in the brass collar just enough to free the spindle. Further withdrawal of the grub screws will upset the alignment of the collar and primary spindle.

(2) To replace potentiometer A, set the potentiometer fully clockwise and set the left-hand drive spindle fully clockwise, ensuring that the three interlocking pins at G are in contact as shown. Insert the potentiometer spindle fully into the hole without rotating. Retighten 3/8 inch nut and both grub screws. Reset drive assembly as in paragraph 5.9.5.

(3) To replace potentiometer B, set the potentiometer to mid position and set the left-hand drive spindle fully clockwise, ensuring that the three interlocking pins at G are in contact as shown. Insert the potentiometer spindle fully into the hole without rotating. Retighten 3/8 inch nut and both grub screws. Reset drive assembly as in paragraph 5.9.5.

5.9.5 Dial and pointer settings

(1) Ensure that the potentiometers and interlocking pins are set as described in paragraph 5.9.1 (4), slacken the screws holding drum N, and move the drum slightly until the pointer is exactly on the 15 MHz mark on the linear scale. Retighten the screws securing drum N.

(2) Rotate the right-hand spindle (potentiometer B) until the pointer is on the 0 mark on the linear scale. Slacken the screws securing the circular dial (left-hand spindle) and rotate the dial until the second graduation (2 MHz) and the sweep width indicator line are together, with the two interlock pins still in contact. Retighten the screws.

(3) Rotate the right-hand spindle further counter-clockwise until the dial indicates zero. Slacken the 3/8 inch nut securing the left-hand potentiometer, and using a multimeter on the ohms range rotate the body of the potentiometer until it is just on its electrical zero, ensuring that the two interlock pins remain in contact. Tighten the nut carefully without disturbing the setting.

(4) Rotate the right-hand spindle clockwise until the pointer indicates 15 MHz on the linear scale, check that the three interlocking pins are in contact, and check that the dial indication is greater than 30.

(5) Rotate the right-hand spindle clockwise until the pointer indicates 30 MHz on the linear scale, check that the two interlocking pins are in contact, and check that the dial indication is approximately 2. Refit the drive assembly into the sweep unit.

Chapter 6

Replaceable parts

Introduction

This chapter lists replaceable parts in alphabetical order of their circuit references, and in the order of the sub-assembly and printed circuit board numbers, as follows :

12 : Fine level
13 : External markers
14 : Internal a.l.c. detector
15 : ALC modulator
16 : Swept oscillator amplifier
17 : Mixer and pre-amplifier
18 : ALC amplifier
19 : Main amplifier and output filter
20 : Swept oscillator
21 : Fixed oscillator
22 : Distorter and drive unit
23 : Internal markers
24 : Fine attenuator
25 : Coarse attenuator
26 : Chassis and front panel

When ordering parts or referring to them in correspondence, use the board number to prefix the circuit reference number, for example 15R1, 23MR6. The following abbreviations are used in the list of replaceable parts :

C : capacitor
Carb : carbon
Cer : ceramic
Elec : electrolytic
L : inductor
Lin : linear
Met : metal
MR : semiconductor diode
PL : plug
Plas : plastic
R : resistor
RV : variable resistor
S : switch
SKT : socket
T : transformer
VT : transistor
W : watts at 70°C
WW : wirewound
XL : crystal
ø : feed-through component
† : value selected during test : nominal value shown

Ordering

When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required.

(1) Type* and serial number of instrument
(2) Complete circuit reference
(3) Description
(4) MI code

* as given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

If a part is not listed, state its function, location and description when ordering.

Circuit reference	*Description*	*MI code*
Unit (12) fine level		
When ordering, prefix circuit reference with 12		
	Complete board	44823-255
C1	Paper 0.002μF 10% 350V	26174-129
C2	Cer 100pF 2% 750V	26324-897
C3	Cer 100pF 2% 750V	26324-897
C4	Cer 0.1μF +50-25% 30V	26383-031
C5	Paper 500pF 20% 600V	26174-122
C6	Paper 500pF 20% 600V	26174-122
C7	Cer 100pF 2% 750V	26324-897
MR1	1N4148	28336-676
R1	Met film 10kΩ 2% ¼W	24773-297
R2	Met film 100kΩ 2% ¼W	24773-321
R3	Met film 47kΩ 2% ¼W	24773-313

Circuit reference	Description	M.I. code
R4	Met film 70Ω 2% ¼W	24773-265
R5	WW 1kΩ 5% 1½W	25123-080
R6	Met film 22kΩ 2% ¼W	24773-305
R7	Met film 22kΩ 2% ¼W	24773-305
R8	WW 1kΩ 5% 1½W	25123-080
R9	Met film 47kΩ 2% ¼W	24773-313
RV1	WW 1kΩ 10% 1W lin.	25811-019
RV2	WW 470Ω 10% 1W lin.	25811-017
RV3	WW 470Ω 10% 1W lin.	25811-017
RV4	WW 1kΩ 10% 1W lin.	25862-381
RV5	WW 500Ω 5% 1W lin.	25817-736
SA	Fine level selector	23462-252
VT1	BCY 70	28434-857
VT2	BCY 72	28433-487
VT3	BCY 72	28433-487

Unit (13) external markers

When ordering, prefix circuit reference with 13

	Complete board	44823-254
C1	Paper 0.001μF 10% 500V	26174-125
C2	Cer 4.7pF ±0.25pF 750V	26324-017
C3	Plas 0.1μF 10% 250V	26582-208
C4	Cer 0.1μF +50-25% 30V	26383-031
C5	Plas 0.033μF 10% 250V	26582-205
C6	Cer 0.1μF +50-25% 30V	26383-031
C7	Plas 0.1μF 10% 250V	26582-208
C8	Elec 22μF +100-20% 40V	26423-222
C9	Cer 22pF ±0.25pF 750V	26324-715
C10	Elec 10μF +100-20% 63V	26423-215
C11	Cer 0.1μF +50-25% 30V	26383-031
C12	Cer ϕ 0.001μF +80-20% 500V	26373-714
C13	Cer ϕ 0.001μF +80-20% 500V	26373-714
L1	Inductor 23mH	44271-607
L2	Inductor 23mH	44271-607
MR1	HG 1005	28323-035
MR2	HG 1005	28323-035
MR3	1N4148	28336-676
MR4	1N4148	28336-676
R1	Met film 1.8kΩ 2% ¼W	24773-279
R2	Met film 1kΩ 2% ¼W	24773-273
R3	Met film 4.7kΩ 2% ¼W	24773-289
R4	Met film 1kΩ 2% ¼W	24773-273
R5	Met ox 1MΩ 2% ½W	24573-145
R6	Met film 47kΩ 2% ¼W	24773-313
R7	Met film 100kΩ 2% ¼W	24773-321
R8	Met film 47kΩ 2% ¼W	24773-313
R9	Met film 6.8kΩ 2% ¼W	24773-293
R10	Met film 47kΩ 2% ¼W	24773-313
R11	Met film 47kΩ 2% ¼W	24773-313
R12	Met film 1kΩ 2% ¼W	24773-273
R13	Met film 4.7kΩ 2% ¼W	24773-289
R14	Met film 8.2kΩ 2% ¼W	24773-295
R15	Met film 4.7kΩ 2% ¼W	24773-289
R16	Met film 33kΩ 2% ¼W	24773-309
R17	Met film 220Ω 2% ¼W	24773-257
R18	Met film 1.2kΩ 2% ¼W	24773-275
R19	Met film 2.7kΩ 2% ¼W	24773-283
R20	Met film 22kΩ 2% ¼W	24773-305
RV1	Carb 22kΩ 20% 2W lin.	25645-397
SA	External marker bandwidth	23462-258

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
VT1	BC 109	28452-777
VT2	BC 109	28452-777
VT3	BCY 70	28434-857

Unit (14) internal a.l.c. detector

When ordering, prefix circuit reference with 14

	Complete board	44823-248
C1	Paper 0.003μF 10% 350V	26174-133
C2	Cer 1pF ±0.25pF 750V	26324-005
C3	Cer 1pF ±0.25pF 750V	26324-005
C4	Cer 0.001μF +80-20% 500V	26383-242
C5	Cer o 0.001μF +80-20% 500V	26373-714
MR1	HP 5082-2800	28349-007
MR2	HP 5082-2800	28349-007
R1	Met film 15kΩ 2% ¼W	24773-301
R2	Met film 220Ω 2% ¼W	24773-257
RV1	Carb 250Ω 20% 0.4W	25541-311

Unit (15) a.l.c. modulator

When ordering, prefix circuit reference with 15

	Complete board	44823-247
C1	Paper 500pF 20% 600V	26174-122
C2	Paper 500pF 20% 600V	26174-122
MR1	1N916	28336-466
MR2	1N916	28336-466
MR3	1N916	28336-466
R1	Met film 180Ω 2% ¼W	24773-255

Circuit reference	Description	M.I. code
R2	Met film 2.2kΩ 2% ¼W	24773-281
R3	Met film 180Ω 2% ¼W	24773-255
R4	Met film 2.2kΩ 2% ¼W	24773-281
R5	Met film 180Ω 2% ¼W	24773-255

Unit (16) swept oscillator amplifier

When ordering, prefix circuit reference with 16

	Complete board	44821-241
C1	Cer 68pF 2% 750V	26324-868
C2	Cer 100pF 2% 750V	26324-897
C3	Paper 500pF 20% 600V	26174-122
C4	Cer ϕ 0.001μF +80-20% 500V	26373-714
C5	Cer ϕ 0.001μF +80-20% 500V	26373-714
C6	Cer 12pF 20% 500V	26333-151
R1	Met film 100Ω 2% ¼W	24773-249
R2	Met film 18kΩ 2% ¼W	24773-303
R3	Met film 6.8kΩ 2% ¼W	24773-293
R4	Met film 12Ω 2% ¼W	24773-227
R5	Met film 1kΩ 2% ¼W	24773-273
R6	Met film 2.2kΩ 2% ¼W	24773-281
R7	Met film 4.7kΩ 2% ¼W	24773-289
R8	Met film 1kΩ 2% ¼W	24773-273
VT1	2N3663	28451-692

Unit (17) mixer and pre-amplifier

When ordering, prefix circuit reference with 17

	Complete board	44823-252
C1	Cer 100pF 2% 750V	26324-897
C2	Elec 2μF +100-20% 25V	26414-109
C3	Paper 0.004μF 10% 250V	26174-137

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C4	Cer 4.7pF ±0.25pF 750V	26324-017
C5	Cer 0.1μF +50-25% 30V	26383-031
C6	Elec 2μF +100-20% 25V	26414-109
C7	Cer 33pF 5% 750V	26324-822
C8	Cer 0.1μF +50-25% 30V	26383-031
C9	Elec 10μF +100-20% 6V	26414-120
C10	Elec 2μF +100-20% 25V	26414-109
C11	Cer 0.1μF +50-25% 30V	26383-031
C12	Plas 0.01μF 10% 630V	26555-463
C13	Elec 5μF +100-20% 15V	26414-113
C14	Var. Cer 3.5-13pF 160V	26847-112
C15	Cer ⌀ 0.001μF +80-20% 500V	26373-714
L1	Inductor 1μH 10%	23642-549
L2	Inductor 1μH 10%	23642-549
MR1	1N82A	28346-114
MR2	1N82A	28346-114
MR3	1N82A	28346-114
MR4	1N82A	28346-114
R1	Met film 1.5kΩ 2% ¼W	24773-277
R2	Met film 4.7kΩ 2% ¼W	24773-289
R3	Met film 220Ω 2% ¼W	24773-257
R4	Met film 220Ω 2% ¼W	24773-257
R5	Met film 220Ω 2% ¼W	24773-257
R6	Met film 220Ω 2% ¼W	24773-257
R7	Met film 4.7kΩ 2% ¼W	24773-289
R8	Met film 15kΩ 2% ¼W	24773-301
R9	Met film 4.7kΩ 2% ¼W	24773-289
R10	Met film 4.7kΩ 2% ¼W	24773-289
R11	Met film 10kΩ 2% ¼W	24773-297
R12	Met film 3.3kΩ 2% ¼W	24773-285
R13	Met film 1kΩ 2% ¼W	24773-273
R14	Met film 68Ω 2% ¼W	24773-245
R15	Met film 2.2kΩ 2% ¼W	24773-281
R16	Met film 470Ω 2% ¼W	24773-265
R17	Met film 2.2kΩ 2% ¼W	24773-281
R18	Met film 1kΩ 2% ¼W	24773-273
R19	Met film 470Ω 2% ¼W	24773-265
R20	Met film 100Ω 2% ¼W	24773-249
R21	Met film 27Ω 2% ¼W	24773-235
R22	Met film 470Ω 2% ¼W	24773-265
R23	Met film 910Ω 2% ¼W	24773-272
R24	Met film 10kΩ 2% ¼W	24773-297
R25	Met film 470Ω 2% ¼W	24773-265
R26	Met film 470Ω 2% ¼W	24773-265
R27	Met film 47Ω 2% ¼W	24773-241
R28	Met film 47Ω 2% ¼W	24773-241
R29	Met film 3.9kΩ 2% ¼W	24773-287
T1	Coil assembly	43551-002
VT1	BSX 20	28452-197
VT2	BSX 20	28452-197
VT3	BSX 20	28452-197

Unit (18) a.l.c. amplifier

When ordering, prefix circuit reference with 18

Circuit reference	Description	M.I. code
	Complete board	44817-208
C1	Paper 0.002μF 10% 350V	26174-129
C2	Plas 0.068μF 10% 250V	26582-207
C3	Plas 0.1μF 10% 250V	26582-208
C4	Plas 1μF 10% 250V	26512-280
C5	Plas 0.047μF 10% 250V	26582-206
C6	Cer 68pF 2% 750V	26324-868
C7	Plas 0.22μF 10% 400V	26555-480
C8	Paper 0.001μF 10% 500V	26174-125
C9	Cer 100pF 2% 750V	26324-897
C10	Elec 1μF +100-20% 50V	26414-106

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C11	Cer 100pF 2% 750V	26324-897
C12	Cer 10pF ±0.25pF 750V	26324-709
C13	Paper 500pF 20% 600V	26174-122
C14	Cer 0.01μF +80-20% 100V	26383-055
C15	Var. Air 3-8.5pF 500V	26816-247
C16	Cer ø 0.001μF +80-20% 500V	26373-714
C17	Cer ø 0.001μF +80-20% 500V	26373-714
C18	Cer ø 0.001μF +80-20% 500V	26373-714
C19	Cer ø 0.001μF +80-20% 500V	26373-714
C20	Cer ø 0.001μF +80-20% 500V	26373-714
C21	Cer ø 56pF 20% 500V	26373-855
L1	Inductor 10μH 10%	23642-555
L2	Coil assembly	35127-703
L3	Printed coil	31817-208
MR1	1N4148	28336-676
R1	Met ox 390kΩ 2% ½W	24573-135
R2	Met ox 330kΩ 2% ½W	24573-133
R3	Carb 6.8kΩ 10% ¼W	24341-306
R4	Carb 3.3MΩ 5% ¼W	24322-978
R5	Carb 680kΩ 10% ¼W	24341-358
R6	Met film 220Ω 2% ¼W	24773-257
R7	Met film 6.8kΩ 2% ¼W	24773-293
R8	Met film 1kΩ 2% ¼W	24773-273
R9	Met film 1.2kΩ 2% ¼W	24773-275
R10	Met film 33Ω 2% ¼W	24773-237
R11	Carb 6.8kΩ 10% ¼W	24341-306
R12	Met film 18kΩ 2% ¼W	24773-303
R13	Met film 1.5kΩ 2% ¼W	24773-277
R14	Met film 1kΩ 2% ¼W	24773-273
R15	Met film 33Ω 2% ¼W	24773-237
RV1	Carb 1MΩ 20% 2W lin.	25645-496

Circuit reference	Description	M.I. code
SA	ALC bandwidth	23462-258
VT1	BSX 20	28452-197
VT2	BCY 72	28433-487
VT3	BSX 20	28452-197
VT4	2N 3663	28451-692

Unit (19) main amplifier and output filter

When ordering, prefix circuit reference with 19

	Complete board	44821-242
C1	Cer 0.1μF +50-25% 30V	26383-031
C2	Elec 2μF +100-20% 25V	26414-109
C3	Plas 0.47μF 10% 250V	26512-264
C4	Cer 0.1μF +50-25% 30V	26383-031
C5	Cer 0.1μF +50-25% 30V	26383-031
C6	Elec 10μF +100-20% 6V	26414-120
C7	Elec 10μF +100-20% 6V	26414-120
C8	Cer 0.1μF +50-25% 30V	26383-031
C9	Cer 0.1μF +50-25% 30V	26383-031
C10	Plas 33pF ±2pF 125V	26516-127
C11	Plas 33pF ±2pF 125V	26516-127
C12	Plas 33pF ±12pF 125V	26516-127
C13	Plas 33pF ±2pF 125V	26516-127
C14	Cer 1.5pF ±0.25pF 750V	26324-008
C15	Cer 0.1μF +50-25% 30V	26383-031
L1	Coil assembly on 8.2MΩ resistor	44231-205
L2	Coil assembly on 8.2MΩ resistor	44231-205
L3	Coil assembly on 8.2MΩ resistor	44231-205
L4	Inductor 10μH 10%	23642-555

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R1	Met film 4.7kΩ 2% ¼W	24773-289
R2	Met film 2.7kΩ 2% ¼W	24773-283
R3	Met film 1.5kΩ 2% ¼W	24773-277
R4	Met film 470Ω 2% ¼W	24773-265
R5	Met film 27Ω 2% ¼W	24773-235
R6	Met film 27Ω 2% ¼W	24773-235
R7	Met film 2.2kΩ 2% ¼W	24773-281
R8	Met film 1.5kΩ 2% ¼W	24773-277
R9	Met film 470Ω 2% ¼W	24773-265
R10	Met film 4.7kΩ 2% ¼W	24773-289
R11	Met film 2.7kΩ 2% ¼W	24773-283
R12	Met film 180Ω 2% ¼W	24773-255
R13	Met film 1kΩ 2% ¼W	24773-273
R14	Met film 3.3kΩ 2% ¼W	24773-285
R15	Met film 12Ω 2% ¼W	24773-227
R16	WW 680Ω 5% 1½W	25123-075
R17	Met film 180Ω 2% ¼W	24773-255
R18	Met film 4.7kΩ 2% ¼W	24773-289
R19	Met film 12Ω 2% ¼W	24773-227
R20	WW 680Ω 5% 1½W	25123-075
R21	Met film 1kΩ 2% ¼W	24773-273
R22	Met film 3.3kΩ 2% ¼W	24773-285
R23	Met film 15kΩ 2% ¼W	24773-301
R24	Met film 5.6kΩ 2% ¼W	24773-291
RV1	WW 100Ω 10% 1W lin	25811-013
T1	Transformer	43545-001
VT1	BSX 20	28452-197
VT2	BSX 20	28452-197
VT3	2N2219	28453-847
VT4	2N2219	28453-847

Unit (20) swept oscillator

When ordering, prefix circuit reference with 20

Circuit reference	Description	M.I. code
	Complete board	44817-206
C1	Cer 68pF 2% 750V	26324-868
C2	Cer 100pF 2% 750V	26324-897
C3	Cer 3.3pF ±0.25pF 750V	26324-014
C4	Cer 100pF 2% 750V	26324-897
C5	Cer ϕ 0.001μF +80-20% 500V	26373-714
C6	Cer ϕ 0.001μF +80-20% 500V	26373-714
C7	Cer 12pF 20% 500V	26333-151
L1	Inductor 1μH 10%	23642-549
L2	Inductor 10μH 10%	23642-555
L3	Coil assembly	44115-403
L4	Printed coil	31817-206
MR1	BA 110	28381-093
MR2	BA 110	28381-093
MR3	BA 110	28381-093
MR4	BA 110	28381-093
R1	Met film 4.7kΩ 2% ¼W	24773-289
R2	Met film 18kΩ 2% ¼W	24773-303
R3	Met film 6.8kΩ 2% ¼W	24773-293
R4	Met film 1kΩ 2% ¼W	24773-273
VT1	2N 3663	28451-692

For symbols and abbreviations see introduction to this chapter

Unit (21) fixed oscillator

When ordering, prefix circuit reference with 21

Circuit reference	Description	M.I. code
	Complete board	44817-207
C1	Cer 68pF 2% 750V	26324-868
C2	Cer 6.8pF ±0.25pF 750V	26324-706
C3	Cer 100pF 2% 750V	26324-897
C4	Cer ⌀ 56pF 20% 500V	26373-855
C5	Cer ⌀ 0.001μF +80-20% 500V	26373-714
C6	Var. Air 2.5-5pF 500V	26816-246
C7	Cer 12pF 20% 500V	26333-151
C8	Cer ⌀ 0.001μF +80-20% 500V	26373-714
L1	Coil assembly	44115-402
L2	Printed coil	31817-207
R1	Met film 2.2kΩ 2% ¼W	24773-281
R2	Met film 18kΩ 2% ¼W	24773-303
R3	Met film 6.8kΩ 2% ¼W	24773-293
R4	Met film 470Ω 2% ¼W	24773-265
R5	Met film 1.3kΩ 2% ¼W	24773-276
R6	Met film 1.8kΩ 2% ¼W	24773-279
R7	Met film 220Ω 2% ¼W	24773-257
VT1	2N 3663	28451-692

Unit (22) distorter and drive

When ordering, prefix circuit reference with 22

Circuit reference	Description	M.I. code
	Complete board	44823-257
MR1	1S 923	28356-018
MR2	1S 923	28356-018
MR3	1S 923	28356-018
MR4	1S 923	28356-018
MR5	1S 923	28356-018
MR6	1S 923	28356-018
MR7	1S 923	28356-018
MR8	1S 923	28356-018
MR9	1S 923	28356-018
MR10	1S 923	28356-018
MR11	1S 923	28356-018
MR11	1S 923	28356-018
MR12	1S 923	28356-018
MR13	1S 923	28356-018
MR14	1S 923	28356-018
MR15	1S 923	28356-018
MR16	1S 923	28356-018
MR17	1S 923	28356-018
R1	Met film 75kΩ 2% ¼W	24773-318
R2	Met film 27kΩ 2% ¼W	24773-307
R3	Met film 3.6kΩ 2% ¼W	24773-286
R4	Carb 1.2kΩ 1% ¼W	24134-120
R5	Carb 1kΩ 1% ¼W	24134-100
R6	Met film 39kΩ 2% ¼W	24773-311
R7	Met film 10kΩ 2% ¼W	24773-297
R8 †	Met ox 430kΩ 2% ½W	24573-136
R9	Carb 1.8kΩ 1% ¼W	24134-180
R10	Met film 910Ω 2% ¼W	24773-272
R11	Met film 51kΩ 2% ¼W	24773-314
R12	Met film 75Ω 2% ¼W	24773-246
R13	Met film 56kΩ 2% ¼W	24773-315
R14	Met film 120Ω 2% ¼W	24773-251
R15	Met film 200Ω 2% ¼W	24773-256
R16	Met film 82kΩ 2% ¼W	24773-319
R17	Met film 300Ω 2% ¼W	24773-260
R18	Met film 430Ω 2% ¼W	24773-264
R19	Met film 110kΩ 2% ¼W	24773-322
R20	Met film 510Ω 2% ¼W	24773-266

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R21	Met film 180kΩ 2% ¼W	24773-327
R22	Met film 680Ω 2% ¼W	24773-269
R23	Met film 180kΩ 2% ¼W	24773-327
R24	Met film 910Ω 2% ¼W	24773-272
R25	Met film 240kΩ 2% ¼W	24773-330
R26	Met film 1.1kΩ 2% ¼W	24773-274
R27	Met ox 330kΩ 2% ½W	24573-133
R28	Met film 1.3kΩ 2% ¼W	24773-276
R29	Met ox 430kΩ 2% ½W	24573-136
R30	Met film 2kΩ 2% ¼W	24773-280
R31	Met ox 510kΩ 2% ½W	24573-138
R32	Met ox 2.7kΩ 2% ½W	24573-083
R33	Met film 150kΩ 2% ¼W	24773-325
R34	Met film 270kΩ 2% ¼W	24773-331
R35	Carb 4.7MΩ 10% ¼W	24322-982
R36	Met film 62kΩ 2% ¼W	24773-316
R37	Met film 5.1kΩ 2% ¼W	24773-290
R38	Met film 82kΩ 2% ¼W	24773-319
R39	Met film 18kΩ 2% ¼W	24773-303
R40	Met film 300kΩ 2% ¼W	24773-332
R41	Met film 150kΩ 2% ¼W	24773-325
RV1	WW 2.5kΩ 1% 3W lin.	44371-241
RV2	WW 1kΩ 10% 1W lin.	25815-115
RV3	WW 1kΩ 10% 1W lin.	25811-019
RV4	WW 10kΩ 10% 1W lin.	25815-134
RV5	WW 1kΩ 10% 1W lin.	25811-019
RV6	Carb 22kΩ 20% ¼W lin.	25611-080
RV7	WW 5kΩ 1% 3W lin.	44371-240
RV8	WW 1.5kΩ 10% 1W lin.	25811-020
RV9	WW 100Ω 10% 1W lin.	25811-013
RV10	WW 1kΩ 10% 1W lin.	25811-019
RV11	Carb 220kΩ 20% ¼W lin.	25611-086
RV12	Carb 220kΩ 20% ¼W lin.	25611-086
RV13	Carb 100kΩ 20% ¼W lin.	25611-084
RV14	Carb 1MΩ 20% ¼W lin.	25611-090
RV15	Carb 220kΩ 20% ¼W lin.	25611-086
SA	Sweep width selector	23462-252
SB	Sweep linearity	23462-252
VT1	BC 107	28455-437
VT2	BC 107	28455-437
VT3	2N 1893	28458-255
VT4	2N 1893	28458-255
VT5	BFW 43	28438-426
VT6	BFW 43	28438-426
VT7	SFT 187	28458-334

Unit (23) internal markers

When ordering, prefix circuit reference with 23

	Complete board	44823-253
C1	Cer 33pF 5% 750V	26324-822
C2	Cer 33pF 5% 750V	26324-822
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Cer 33pF 5% 750V	26324-822
C5	Cer 0.1μF +50-25% 30V	26383-031
C6	Elec 1μF +100-20% 50V	26414-106
C7	Cer 0.1μF +50-25% 30V	26383-031
C8	Cer 100pF 2% 750V	26324-897
C9	Cer 0.1μF +50-25% 30V	26383-031
C10	Cer 0.1μF +50-25% 30V	26383-031
C11	Cer 0.01μF +80-20% 100V	26383-055
C12	Paper 500pF 20% 600V	26174-122
C13	Cer 0.1μF +50-25% 30V	26383-031
C14	Paper 300pF 20% 600V	26174-119
C15	Cer 0.001μF +80-20% 500V	26383-242
C16	Cer 0.01μF +80-20% 100V	26383-055
C17	Plas 0.0015μF 2% 125V	26516-524

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
C18	Plas 0.0015μF 2% 125V	26516-524
C19	Plas 0.004μF 2% 125V	26516-629
C20	Plas 0.0028μF 2% 125V	26516-591
C21	Plas 0.1μF 10% 250V	26582-208
C22	Plas 0.01μF 10% 630V	26555-463
C23	Paper 500pF 20% 600V	26174-122
C24	Elec 10μF +100-20% 63V	26423-215
C25	Cer 0.1μF +50-25% 30V	26383-031
C26	Var. Cer 4.5-20pF 160V	26847-114
C27	Cer ø 0.0047μF +80-20% 500V	26373-665
C28	Cer ø 0.0047μF +80-20% 500V	26373-665
C29	Cer 0.1μF +50-25% 30V	26383-031
L1	Inductor 100μH 10%	23642-561
L2	Coil assembly	44233-208
L3	Coil assembly	44237-207
L4	Inductor 100μH 10%	23642-561
L5	Inductor 100μH 10%	23642-561
MR1	1N4148	28336-676
MR2	HG 5004	28332-465
MR3	HG 5004	28332-465
MR4	1N 916	28336-466
MR5	1N 916	28336-466
MR6	1N4148	28336-676
MR7	1N4148	28336-676
MR8	Z5B11	28372-033
R1	Met film 220kΩ 2% ¼W	24773-329
R2	Met film 100Ω 2% ¼W	24773-249
R3	Met film 22kΩ 2% ¼W	24773-305
R4	Met film 47kΩ 2% ¼W	24773-313
R5	Met film 4.7kΩ 2% ¼W	24773-289
R6	Met film 4.7kΩ 2% ¼W	24773-289
R7	Met film 33kΩ 2% ¼W	24773-309
R8	Met film 12kΩ 2% ¼W	24773-299

Circuit reference	Description	M.I. code
R9	Met film 2.2kΩ 2% ¼W	24773-281
R10	Met film 1.5kΩ 2% ¼W	24773-277
R11	Met film 1kΩ 2% ¼W	24773-273
R12	Met film 12kΩ 2% ¼W	24773-299
R13	Met film 33kΩ 2% ¼W	24773-309
R14	Met film 2.2kΩ 2% ¼W	24773-281
R15	Met film 3.3kΩ 2% ¼W	24773-285
R16	Met ox 330kΩ 2% ½W	24573-133
R17	Met film 1.2kΩ 2% ¼W	24773-275
R18	Met film 1kΩ 2% ¼W	24773-273
R19	Met film 22kΩ 2% ¼W	24773-305
R20	Met film 100kΩ 2% ¼W	24773-321
R21	Carb 15kΩ 5% ¼W	24312-914
R22	Met film 15kΩ 2% ¼W	24773-301
R23	Met film 24kΩ 2% ¼W	24773-306
R24	Met film 18kΩ 2% ¼W	24773-303
R25	Met film 100Ω 2% ¼W	24773-249
R26	Met film 2.2kΩ 2% ¼W	24773-281
R27	Met film 1.2kΩ 2% ¼W	24773-275
R28	Met film 12kΩ 2% ¼W	24773-299
R29	Met film 68Ω 2% ¼W	24773-245
RV1	Carb 10kΩ 20% ¼W lin.	25611-078
RV2	Carb 4.7kΩ 20% ¼W lin.	25611-076
T1	Transformer	44236-201
VT1	BSX 20	28452-197
VT2	BSX 20	28452-197
VT3	BSX 20	28452-197
VT4	BSX 20	28452-197
VT5	BSX 20	28452-197
VT6	BCY 72	28433-487
VT7	BCY 72	28433-487
XL1	5MHz 0.005%	28311-903

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
Unit (24) fine attenuator		
When ordering, prefix circuit reference with 24		
C1	Cer 3.3pF ±0.25pF 750 V	26324-014
C2	Cer 3.3pF ±0.25pF 750V	26324-014
R1	Metal film 75Ω 1% ¼W	24636-475
R2	Metal film 1.30kΩ 1% ¼W	24637-103
R3	Met film 8.65Ω ½% ¼W	24634-078
R4	Met film 1.30kΩ 1% ¼W	24637-103
R5	Met film 654Ω 1% ¼W	24636-804
R6	Met film 17.03Ω ½% ¼W	24634-105
R7	Met film 654Ω 1% ¼W	24636-804
R8	Met film 331Ω 1% ¼W	24636-715
R9	Met film 35.79Ω ½% ¼W	24634-233
R10	Met film 331Ω 1% ¼W	24636-715
R11	Met film 331Ω 1% ¼W	24636-715
R12	Met film 35.79Ω ½% ¼W	24634-233
R13	Met film 331Ω 1% ¼W	24636-715
SA	Fine attenuator (switch)	44326-423
Unit (25) coarse attenuator		
When ordering, prefix circuit reference with 25		
C1	Cer 2.2pF ±0.25pF 750V	26324-011
C2	Cer 1.5pF ±0.25pF 750V	26324-008
C3	Cer 2.2pF ±0.25pF 750V	26324-011
C4	Cer 3.3pF ±0.25pF 750V	26324-014
R1	Met film 91.68Ω ½% ¼W	24634-482
R2	Met film 371Ω ½% ¼W	24634-704
R3	Met film 91.68Ω ½% ¼W	24634-482
R4	Met film 91.68Ω ½% ¼W	24634-482
R5	Met film 371Ω ½% ¼W	24634-704
R6	Met film 91.68Ω ½% ¼W	24634-482
R7	Met film 144.4Ω ½% ¼W	24634-613
R8	Met film 106.8Ω ½% ¼W	24634-612
R9	Met film 144.4Ω ½% ¼W	24634-613
SA	Coarse attenuator (switch)	44324-825
Unit (26) chassis and front panel		
When ordering, prefix circuit reference with 26		
PL1	24-pin	23435-610
SA	Markers	23462-257
SKT1	BNC 50Ω coaxial	23443-443
SKT2	BNC 75Ω coaxial	23443-806 23443-807

For symbols and abbreviations see introduction to this chapter

Chapter 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms.
Capacitors: No suffix = microfarads, p = picofarads.
† value selected during test, nominal value shown.

2. VOLTAGES

Shown in italics adjacent to the point to which the measurement refers. See section 5.8.1 for conditions.

3. SYMBOLS

arrow indicates clockwise rotation of knob.

RANGE etc., external front or rear panel marking.

preset control.

(31) unit identification number.

point marked with this symbol is connected to and receives power from point marked with this symbol

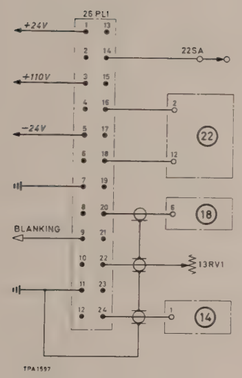
These symbols are used to identify branches of the power supply circuitry but have no particular physical reality on the printed boards.

4. CIRCUIT REFERENCES

These are, in general, given in abbreviated form.
See also introduction to Chapter 6.

5. SWITCHES

Rotary switches are drawn schematically.
Letters indicate control knob settings.
1F = 1st section (front panel), front
1B = 1st section, back
2F = 2nd section, front
etc.



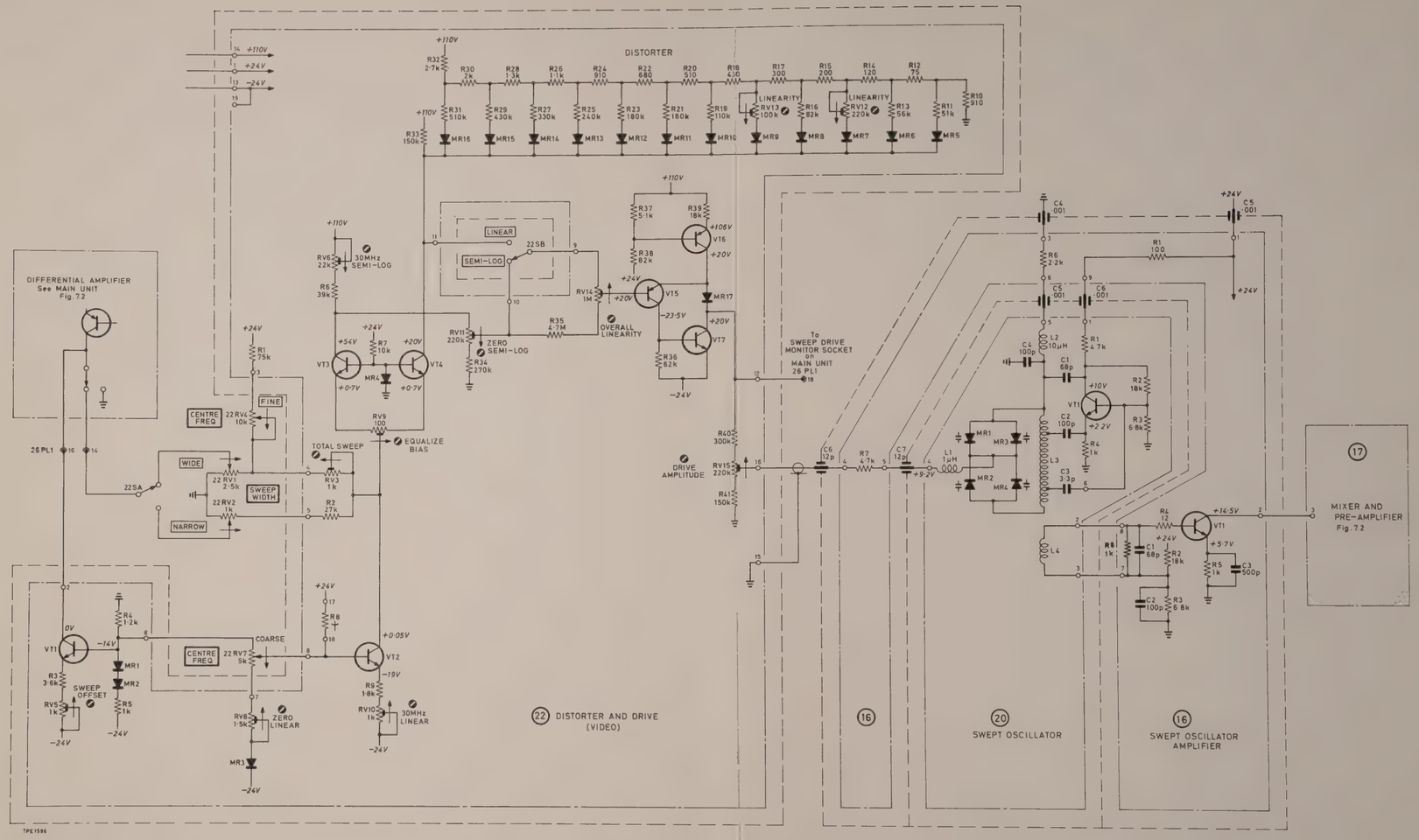


Fig. 7.1 Circuit diagram—Drive and swept oscillator

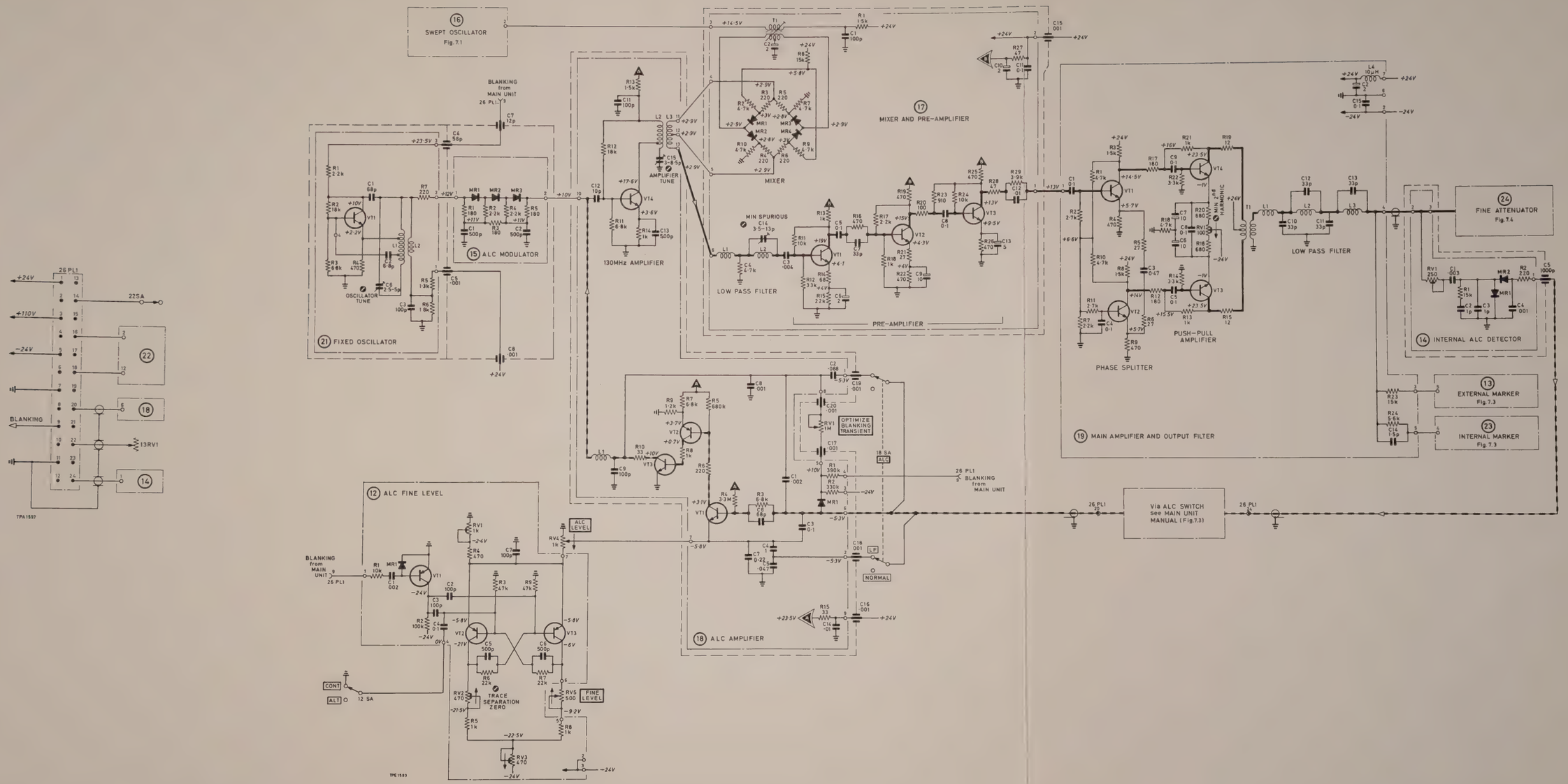
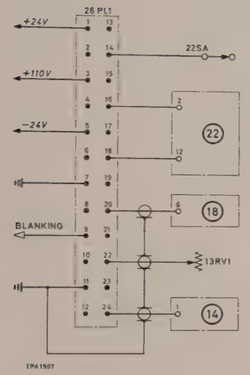


Fig. 7.2 Circuit diagram—Amplifiers and a.l.c.



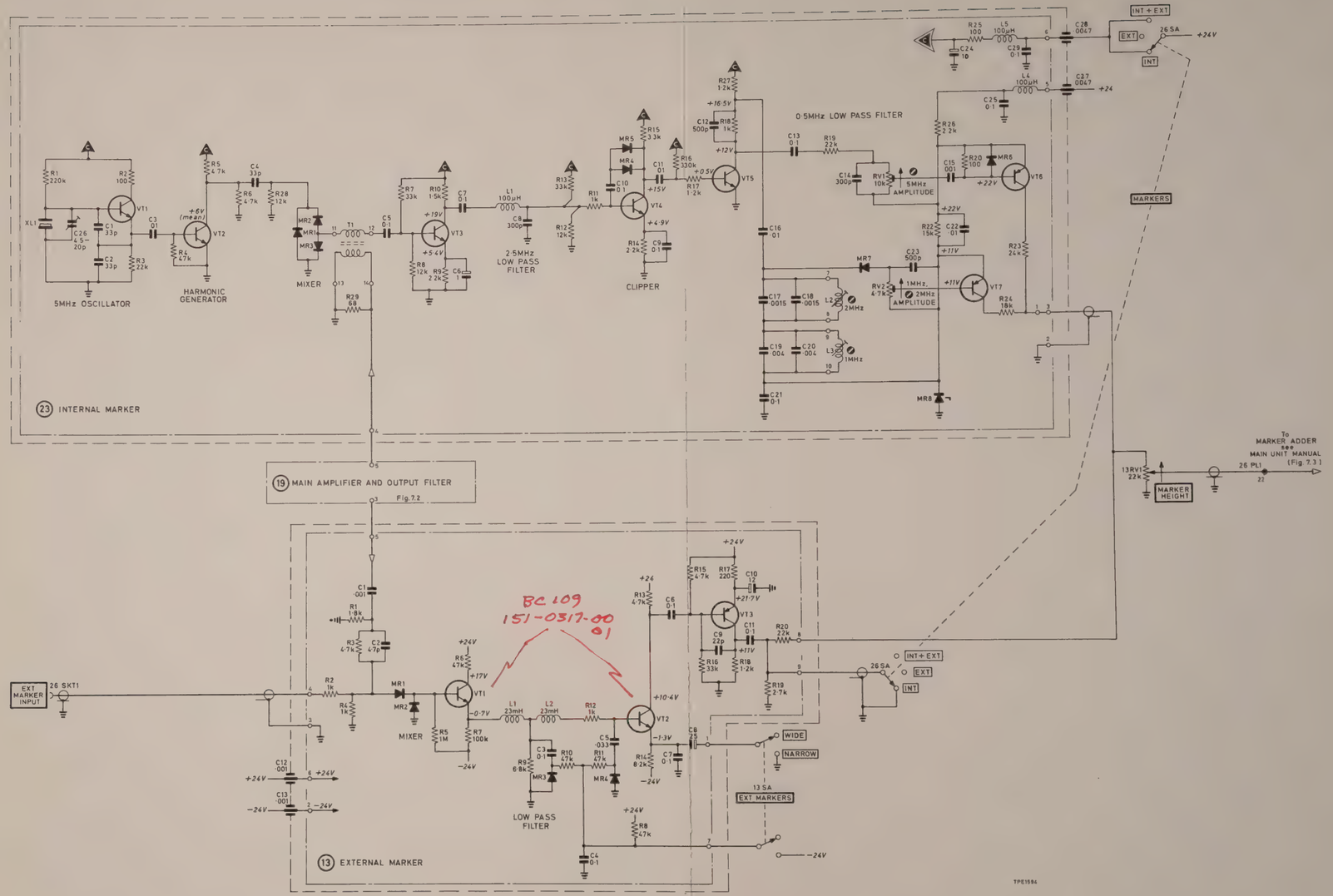


Fig. 7.3 Circuit diagram—Markers

ATTEN dB	PADS IN CIRCUIT			
	1	2	4	4
0	—	—	—	—
1	TT	—	—	—
2	—	TT	—	—
3	TT	TT	—	—
4	—	—	TT	—
5	TT	—	TT	—
6	—	TT	TT	—
7	TT	TT	TT	—
8	—	—	TT	TT
9	TT	—	TT	TT
10	—	TT	TT	TT
11	TT	TT	TT	TT

ATTEN dB	PADS IN CIRCUIT		
	20	20	10
0	—	—	—
10	—	—	TT
20	—	TT	—
30	—	TT	TT
40	TT	TT	—
50	TT	TT	TT

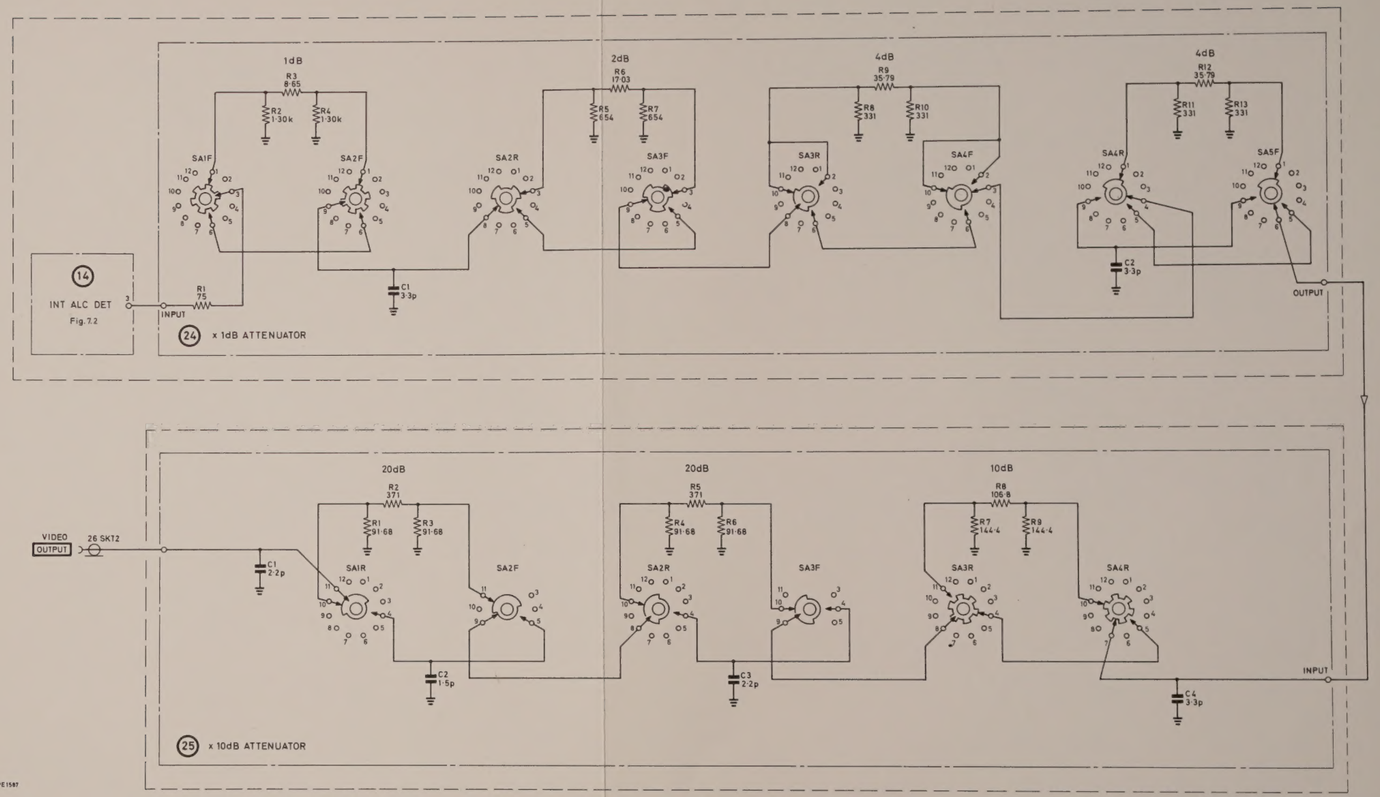


Fig. 7.4 Circuit diagram—Attenuators

TM 9692

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